DOCUMENT COPYING
AND REPRODUCTION PROCESSES

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by

H R VERRY · FIBP · ARPS

Advisor to H.M. Treasury (Organisation and Methods Division) on Photographic, Document Copying and Reproduction Processes.

Chairman of the Document Copying Groups of The British Institute of Management and The Association of Special Libraries Information Bureau (ASLIB)

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ANY AUTHOR who writes about a subject with which he is familiar must be haunted by two fears:

1. That he will forget to say something of importance;
2. That what he does say may not be sufficiently clear to those whose knowledge of the subject is more restricted.

For the help they have given in reminding me of some of the points overlooked and in clarifying the ambiguous, I am indebted to my many colleagues and business friends in the reproduction world.

I am particularly indebted to my late friend, William Lord, who, at my request, made long and extensive research into the lesser-known fields of reproduction and thereby provided me with much helpful and useful information. The arduous and thankless task of ascertaining the comparative costs of all the reproduction methods was undertaken by him with painstaking zeal and energy. I offer grateful, if inadequate, thanks.

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PART SEVEN

PREFACE

THE PURPOSE of this book is to make a survey of all the generally used methods of reproduction, from simple carbon copying to the minor offset and small typeset machines. No attempt has been made to outline the wider and more comprehensive field of professional printing. The machines used in these processes are large and costly, and require long training with considerable skill to operate them. Generally they are intended to produce a larger number of copies than is economical by any of the duplicating processes.

The information in this review is not intended to be comprehensive. The continuing progress in both machines and the materials used would soon outdate such information. The aim has been rather to outline the general principles concerned and to indicate the possibilities of each process and its suitability for particular requirements.

Nor is this book intended to be a manual of instruction. The numerous processes and methods outlined make detailed working information impracticable. It would also be superfluous. Suppliers of both machines and materials are anxious that their products should be used to the best advantage and to this end they are prepared to give adequate training to all operators and, at all times, send out experienced staff to help when difficulties arise. They also have a wide selection of booklets intended to assist those who use their materials.

This book has therefore been designed chiefly to be of value to those who have little knowledge of the principles of reproduction and also to assist those who are already familiar with some, but not all, of the processes reviewed.

The author, long familiar with these processes both in this and other countries, is fully aware of the difficulty of explaining them in simple language. They are by their nature somewhat technical and difficult to explain. He must, therefore, crave the indulgence of those whose knowledge of these methods is advanced and thereby may feel that many of the detailed descriptions are perhaps a little superfluous. For those less fortunate, a glossary of the terms used,

together with charts and illustrations, is included for reference.

A number of the charts included summarize the type of work each process is able to do and the number of copies they produce economically. It may be helpful to consider these, since they serve to indicate that no one process is able to meet all the requirements in the wide field of reproduction, although some can be used for a variety of purposes.

Where applicable, the theoretical running speeds of the duplicating machines have been quoted. The speeds given indicate the maximum number of copies which may be produced by the machines in one hour. These speeds could never be maintained under operational conditions, owing to the numerous factors which necessarily restrict the output. For instance, when short-run work is required, the master must be frequently changed and the machine made ready for the next run. Whilst this is being done the machine is not producing copies, and therefore cannot produce the same average as when it is employed on long-run work, requiring infrequent master changes and the minimum of machine attention.

The speeds given are therefore intended only as a rough guide. Under favourable conditions it may be possible to produce about two-thirds of the maximum speed output, but with normal working conditions probably only 50 per cent or less of the theoretical speed may be obtained.

A possible output of some of the photocopying machines has been quoted. Figures of this nature are quite controversial, since they vary according to conditions and with factors too numerous to mention. Perhaps not the least among these is the skill of the machine operator and his/her working capacity. The quoted figures must therefore not be taken too literally, but regarded as indicative rather than factual.

Addressing machines, which may be considered as a method of reproduction, are included in this review. During recent years these machines have widened their possible applications. Today they are linked with punched card machines and are able to do printing at high speeds. It is therefore not possible to describe in one chapter so wide and comprehensive a field. Those requiring more detailed information should consult the manufacturers or the books dealing solely with this subject.

The author has indulged in a certain amount of repetition where important considerations are concerned. It is hoped that the reader may excuse this procedure. It is done to emphasize the points which are considered to be of value; to make each chapter reasonably complete in itself and also in the belief that repetition of important points is not harmful in a detailed study of reproduction methods.

PART ONE

CHAPTER I

DOCUMENT REPRODUCTION

A Brief Survey

THE PROLOGUE to reproduction reaches far back into the dawn of history, when man first began to realize the need for communication. The discovery that he could convey his meaning by sound led inevitably to a desire to record in more permanent form. Those who through the centuries sought a means of achieving this ideal laid the foundation of perhaps the most noticeable contribution which has been made by man for man.

These men, who with crude tools cut out word symbols in moist clay or carved with hammer and chisel, or with plume pen and papyrus, chronicled the doings of their age, became the historians of the past and blazed the trail, of which the present widespread method of communication is but the inevitable result.

Having created a document, man's next ambition was to reproduce it. The humble beginnings of this great urge are to be found in apparatus which was in common use in Nineveh as far back as 1,000 years B.C. This was a simple hand duplicator, consisting of an engraved cylinder mounted in a frame, and when rolled over a slab of soft clay it created a copy which was then dried in the sun. From such apparatus the present widespread use of reproduction methods has evolved.

It has been claimed that we live in a 'paper' age and that the efficient organization within industry and commerce depends largely on the paper behind it. Whilst professional printing presses have been widely used to distribute books, journals and other literature, there is still within every organization a great need for some method of reproducing quickly and cheaply material which does not economically justify printing by conventional means.

Office economists directed their early efforts to the problems of mechanical reproduction. One practice consisted of writing the original in ink to which sugar or gum had been added and placing the copy in contact with a damp tissue. This was followed by other

ink-transfer methods, and later by the introduction of the wax stencil, then finally by offset litho and other processes.

The desire to produce single or low-multiple copies from originals already in existence led to the principles of photography being employed and to the development of a wide range of photocopying processes, which now include electronic and other methods.

With the development of modern office organization the demand for more rapid, efficient and economical reproduction has increased. Processes long in existence have been modernized to make it possible for them to undertake work for which they were once considered unsuitable. The addition of new and improved materials has enabled the previous limits of some of the short-run processes to be extended and, conversely, permitted methods long considered only suitable for a minimum of 2,000 copies to produce economically a few copies only.

The variety of available processes, machines and material has now made it more difficult to determine which process is the most suitable for a particular purpose. In prewar years this selection was less complicated and the few available methods could be easily classified as short, medium and long run systems. The development of new processes and materials have now made such a classification obsolete.

Experts have long argued that there is always one best way of meeting every reproduction problem, but this viewpoint cannot now be taken too literally. Whilst it is obvious that it is not normally possible to produce economically a single copy and 1,000 copies by the same process, it is frequently possible to meet some reproduction problems by a number of different processes, with little variation in the cost involved.

The selection of a suitable process for a particular type of work can only be determined by a thorough examination of all the factors concerned, and a study of the available methods which are able to meet the known requirement. The author of this book recognizes the difficulty in making this selection. The detailed outline of the processes is included to familiarize the reader with their possibilities and to enable their advantages and disadvantages to be weighed against the other available factors when consideration is being given to the selection of the most suitable method. The reproduction chart included in the Appendices has also been designed to facilitate this selection.

As a more general guide, the following important points should also be considered.

The photocopying processes are suitable for the reproduction of *a limited number of copies from originals already in an acceptable*

form. These processes are particularly useful for copying technical journals, typed letters and similar documents.

Addressing machines provide a means of reproduction, not only of envelopes but of other documents. It is usually claimed that the difference between the duplicating and addressing methods is that duplicating is intended to produce a number of copies on a single occasion, whilst the addressing machine is designed to produce a single or a few copies on a large number of occasions. Recent developments, however, have made it economical in some circumstances to reproduce up to 1,000 copies from a single addressing master. However, the amount of information which can be contained on an addressing master is limited.

Microfilm and similar techniques are used not only to reduce space but – especially with the flat techniques – as a method of reproducing cheaply and effectively documents which, by their bulk, create unnecessary work in sorting and finding. They can also be considered as a means of publication for books and periodicals which are out of print. Also, they are now being increasingly used in business systems where they are able to eliminate much clerical work. It is in this field that the technique has been much neglected. When more fully understood and appreciated, the use of microfilm in clerical procedures will be more widely applied.

From long experience with these techniques, the author is fully aware of the general reluctance to use them. However, in view of the growing need for space and more space, together with the fact that, in spite of the objections associated with it, microfilm as a space saver has no equal, indeed no alternative, these processes have therefore been briefly discussed.

The flat techniques have been stressed to indicate to those with extreme prejudice against microfilm in roll form that other methods are available which may, to some extent, overcome their objections. It cannot, however, be too strongly emphasized that if documents are microfilmed intelligently, by using index cards or other means to break up the material in a manner that will make selection easier, many of the objections now made to its use in roll form will be found to be more hypothetical than factual.

Also, it is apparent that microfilm has possibilities far beyond its normally considered purpose. Linked with electronic and other devices, it is able to store in condensed form information which can be rapidly found and reproduced. In this way it may make its greatest and most far-reaching contribution to science and industry.

Plan-copying methods are used to make copies of engineers' and similar drawings, tracings, plans and other material. They are able

to produce copies only from a translucent original and cannot print from opaque originals without the use of an intermediate master.

The duplicating processes differ from other methods in that they have been specially developed to produce a number of copies from a typed or specially prepared master. The length of run is determined chiefly by the method used, since the spirit process is limited by the density of the dye deposited on the master, but the offset method, with modern plate-making techniques, is able to produce runs far in excess of normal duplicating requirements or their possible economic limits. In this connection, the author feels that duplicating methods are not normally economical for extremely long runs where the job contains a number of pages. The volume of related material requires collating and binding by processes which, compared with the methods used in the printing profession, are slow and costly. Large printing machines are able to print many pages on each sheet. These can be collated, folded and stitched by machine methods at high speeds, reducing the cost of this ancillary work.

It may be considered, but it is by no means specific, that 10,000 sheets which may contain a number of pages on each sheet is a reasonably economic limit for duplicating methods. For numerous reasons it may be necessary to exceed this number, but it may then be found that such long runs could be done more economically by professional printing methods, unless the internal organization is not working at full capacity.

In later chapters methods are outlined which are intended to give to duplicated copies the easy readability of a printed book. It has long been considered that duplicated copies must be inferior in appearance to printed material. The composing typewriter and other machines are narrowing the gap which has previously existed. We are now able to class the results as 'near print,' which means that we have reached a stage where duplicated copies can be both pleasing in appearance and of good quality.

CHAPTER II

CONSIDERATIONS IN PROCESS SELECTION

THE PREVIOUS broad outline of the processes used in reproduction has been given to indicate their particular sphere of usefulness. When selecting the most suitable process or machine for work of a specific nature a number of important factors must be considered.

Documents which are required to be reproduced may differ considerably in size and type so that it may not be possible to meet all requirements by apparatus already employed in a reproduction section. To assist, therefore, in making a selection of appropriate apparatus for a given requirement, the following important factors are briefly classified:

(1) Cost.
(2) Number of copies required.
(3) Quality.
(4) Durability.
(5) Size of copy.
(6) Type of original.
(7) Colour.
(8) Urgency of work.

COST

Cost is important, and normally preference is given to the most economical process suitable for the work. Many of the other considerations are given chiefly to decide which method can be most economically used. In assessing this factor the two considerations necessary are the initial and the repetitive costs of each process. The photographic methods have a low initial cost but it is repetitive. The cost of producing a number of photographic copies is multiplied by each additional print. For this reason they are considered as short-run processes. Some of the newer photocopying methods have a somewhat higher initial cost than the older type, but the use of diazo paper has provided a lower repetitive cost.

The plan-copying processes are also cost repetitive, but the material cost is much lower than that of the photographic paper.

Another important consideration in the case of the plan-copying machines is that they are able to produce copies of a large size and that the alternative processes able to undertake such work are costly, except on extremely long runs.

Duplicating processes have a high initial cost, since usually the master must be typed or negatives prepared by the process camera or other means. The running cost is comparatively cheap so that short runs would normally be expensive, but long runs would automatically reduce the cost per copy.

The chapters on the economics of document copying deal more comprehensively with this consideration.

NUMBER OF COPIES REQUIRED

All processes and materials are designed for either short- or long-run work so that the number of copies required has a considerable influence on the process, the apparatus and the material to be used. Exceptions may be necessary owing to other considerations as given below. The chart in the Appendices outlines the normal economic run of each process.

QUALITY OF REPRODUCTION

There are only a few processes in the normal reproduction range capable of producing work of the highest quality. Therefore if top-quality copies are required, methods able to produce the better quality work must be used, even though they may not be the most economical.

DURABILITY

Copies which are required for archival and similar purposes are expected to remain in a readable condition over long periods. Prints prepared for such purposes are restricted to those processes or techniques able to produce permanent copies. Some processes can produce a fugitive or durable image, depending on the technique employed.

In photocopying such work must be processed by methods which are able to produce a durable image. The use of two fixing baths is recommended when using silver halide paper. One new bath should be prepared each day and the fixing operation should be completed by immersing the print in the new fixing bath, following the normal period of fixation in the older solution. Thorough washing in efficient apparatus is also essential.

SIZE OF COPY

Many of the machines later discussed are not able to accommodate or produce large-size copies. Some are restricted by the width of the copy obtainable but not by the length. Those designed for office use are frequently limited to about 13 × 16 in. Sizes required in excess of this are restricted to machines or processes able to produce them, unless they are acceptable when printed in sections and finally pieced together.

When copies are required to be reduced in size from the original a camera, Photostat, Photoscope, or similar equipment will be essential to make the reduction, and, where necessary, the reduced intermediary master.

In the photocopying range Photostat and Xerography are at present the only processes able to make enlarged or reduced copies other than those methods described as reduction processes.

TYPE OF ORIGINAL

Apart from size and quality, originals may contain numerous colours, be stained by age or of a poor quality. These are limiting factors in the choice of a suitable process and selection will be restricted to those using material which is colour-sensitive.

COLOUR

When more than one colour is required in the final copy the choice is confined to the duplicating processes. If good quality half-tone reproductions in colour are necessary, it will further limit the processes available for this type of work. In exceptional cases and when only a few copies are required, the use of colour photography may be essential.

URGENCY OF WORK

Occasional urgent work does not call for special machines or methods. Where urgent work is regularly required it is necessary to use the processes which are able to produce the copies quickly. In photocopying using silver halide paper, the semi-dry processing method is able to give a copy with a minimum delay and is therefore essential in dealing with work of extreme urgency.

CLASSIFIED SELECTION

Bearing in mind the points previously outlined, the following considerations are those of chief importance when examining any

request for reproduction work or apparatus. Firstly, it is essential to examine carefully the documents to be copied, to note their size and quality and the number of single- or double-sided originals. Next in importance is the number of copies required, which will determine whether it is proper to the photocopying or the duplicating groups.

If the request is merely for single copies the choice may then lie between the transfer processes, Thermofax and direct positive silver paper. The high initial cost of the transfer and Thermofax methods is somewhat offset by the convenience and the operational speed of these processes. However, if the original documents contain a high percentage of single-sided originals on a reasonably translucent paper, direct silver positive paper would then be worth consideration. This paper would produce directly a single copy from a high percentage of the originals without a negative or other intermediate master, thus giving an economy in paper and yet providing a positive copy on cheaper sensitive material. For this reason the Photostat machine is also economical for single copies, when the readable negative is acceptable.

Where more than two or three copies are required from the same original there can be little doubt that, unless the total requirement is extremely small, it will be more economical to employ the Verifax process or one which produces the final prints on diazo paper. The advantages and disadvantages of these methods will need consideration, but where repeat copies are frequently required it may be found that those processes creating a storable intermediate master would be preferable.

The occasion will sometimes arise when there are requests for larger-size work or longer runs than the existing equipment is normally expected to produce. Unless the near future is expected to change this position it will be found more economical to send such work to another section or a trade house, or, in the case of long runs, to misuse the process for this occasional work. Larger copies can sometimes be folded and copied in sections, the final result being pasted together; not an entirely satisfactory method, but probably suitable in an emergency. The misuse of photocopying methods by making them provide more copies than is economical should generally be strongly discouraged, but it may be justified for an occasional urgent request. The alternative to both these methods would be to install larger and faster machines or to employ entirely different processes, having increased production costs which would offset any advantages they may otherwise offer.

It is, however, important when examining a request for some

copying or reproduction apparatus to consider not only the present requirement but also possible future needs. Whilst the larger and more expensive apparatus should not be allowed on the assumption that the demand may increase, few things can be more exasperating than to install apparatus that is adequate for the present and then to find in a few months' time that the usefulness of the machine has drawn to it work not previously considered. A small machine overburdened by increasing demands and attempting to provide more work than it is designed to do can be most uneconomical on labour and when judged without knowledge of the circumstances under which it was installed can reflect seriously upon the decision of those who originally selected and installed the apparatus. It can also be claimed that larger apparatus – particularly of the box type – enables a number of small copies to be made simultaneously, thus effecting an economy in time. For this reason, when increasing requirements justify additional equipment, it is often more economical to withdraw the original machine, replacing it by one able to produce a far greater output and therefore meet the present demands without the need for additional staff.

The economics of document copying are more fully discussed in a later chapter. Charts are also given in the Appendices, outlining the relative costs of most of the processes later described. Also included is a chart which gives, together with other information, the basic material costs of these methods. It is hoped that this information will help the reader to acquire some appreciation of the relative basic costs involved as this may be useful when the methods are only occasionally used by staff already employed on other duties.

The following outline of the processes used in photocopying and reproduction is given to summarize their principal features and to indicate the type of work for which they are most suitable. This information will assist the reader to determine the process most appropriate to his need and help him to estimate the value of certain methods for his requirements.

The author, long experienced in advising on reproduction matters, is of the opinion that those who seek advice are better prepared to apply the method if their search is first narrowed to an appropriate channel and they are allowed to discover the final answer by their own efforts. By this means they retain a personal interest in the problem and with the knowledge acquired in the search are able to be of practical help should teething troubles arise after the inception of the chosen machine.

The classified list of suppliers contained in the Appendices is therefore included for guidance. It is hoped that those who require

more specific information will contact the firms concerned, and from a detailed analysis of their apparatus lists will be able to select such equipment as is best able to meet their needs, at the price they are prepared to pay for it.

Many readers may feel that it would have been more helpful if the author had specified the apparatus which he considers recommendable. Such a procedure, whilst helpful in a magazine article, would serve no useful purpose in this book as it would soon be outdated. The continuing progress both in machines and methods necessitates a careful examination at frequent intervals of the developments which have been made. To this end, it is strongly recommended that such exhibitions as may be arranged should be visited whenever possible and new literature dealing with these subjects be studied regularly.

The Business Efficiency and similar exhibitions, some of which are frequently arranged locally by the Office Management Association, can be of practical assistance in making this selection. The opportunity to inspect these machines and see them demonstrated will indicate the type of copy they are able to produce and their relative usefulness.

CHAPTER III

CARBON COPIES

THE NORMAL method of making a limited number of copies is by means of carbon paper placed beneath the document being made and between sheets of thin typing paper. By manual, typewriter or other machine methods the top sheet is created, and reproduced on the under sheets by the carbon paper.

The carbon method is still extensively used, although restricted in its scope by a number of limitations. Perhaps the most important of these is, not the number of readable copies which can be produced at the same time, but the number of *acceptable* carbon copies which can be created simultaneously.

The quality of the carbon used is possibly the chief factor which determines this number. Carbon paper can be coated to any degree of hardness or sensitivity; the hard-coated ones have longer-wearing qualities, are cleaner to handle and do not smudge. They also give the best impression with small typeface and are more easily corrected.

With typewriting, the platen, together with a correct use of both carbon and paper, has also a considerable influence on the number of copies which can be obtained. With a correct combination of these three factors it may be possible, in favourable circumstances, to obtain up to twenty copies at one typing. The fatigue factor would be considerably increased, owing to the weight of strike necessary to obtain this number, and result in some loss of output when using the normal type of machine.

For normal purposes, it is considered that five or six carbon copies would be as many as could be expected. If very thin paper, a hard platen and a good machine are used, this number may possibly be increased to about ten or twelve copies.

The electrically operated machines can produce up to twenty copies, but this is not of very great practical use. The thinness of the paper required to achieve this number has disadvantages, and the blurred appearance of many of the final copies makes them normally unacceptable. It is also important to remember that electric typewriters, which are now so widely used for making reproduction

masters, generally give a greater percentage of error than do the manual type. This is because the slightest touch on the key will strike the letter mechanically; there is no time to withdraw the hand before the key has struck, and therefore no opportunity to change the mind nor a chance to retrieve an error. For this reason, the practice of using these powered machines for creating so many carbon copies is of questionable value.

The main disadvantage of the carbon method is the necessity to correct not only the top copy but also each subsequent carbon copy. When mistakes are discovered in the checking process, the individual sheets must be replaced separately in the typewriter for correction. The appearance of a correction – which itself is generally of good density and clarity ('top copy quality') – on a blurred carbon copy, is not acceptable when good-quality work is required.

This point has been humorously but factually described in the following lines:

> The Boss no question makes of Ayes and Noes,
> Each error on the carbon shows.
> And tho' her rubbings out be well concealed,
> He knows about it all, he knows, he knows.

It has long been generally agreed that the carbon copy provided an intermediate stage between writing and duplicating. With the increased use of the translucent master and rotary machines designed for the rapid and economical production of photocopies, it is now questionable whether the method of making carbon copies, particularly more than two copies, is economically sound, except in very small offices where the use of a photocopier could not be justified.

From a survey of the various examinations made, both in this and other countries, of the cost of producing each carbon copy, it would seem that generally this additional cost is approximately 15 per cent per carbon copy. This figure is, of course, determined by many variable factors, all of which require careful consideration, but it may be taken as a rough-and-ready guide when estimating the additional cost of making carbon copies.

When considering this factor, it must also be remembered that the interleaving and de-interleaving of carbon and copy paper is wasteful of time and therefore expensive. Observe any typist using loose forms and carbons, notice the time she takes to assemble them, knock them into alignment, insert them in the typewriter, realign them, and then later remove them from the machine and separate them, one by one. It has been stated that where a number of carbon copies are frequently required, the preparation of the work takes

longer than the actual typing time. Tests have proved that the typist's time required for this work can be considerably reduced by employing an unskilled girl to do the collating. This will allow the skilled typist to produce a greater output of typed material. The method, however, has certain disadvantages and cannot be used except in large typing pools or where typists are centrally controlled.

To avoid this work of interleaving, a number of methods are available which use continuous stationery, of the interfold or fanfold type, in special machines or typewriter attachments. These not only save the work of inserting carbons, but also reduce the possibility of their being inserted wrongly or of worn-out carbons being used, and therefore eliminate many of the disadvantages of the carbon method.

The carbon sometimes used in this type of stationery is frequently that known as 'one time carbon,' but some systems are able to hold the sheets of carbon paper in the same position while the continuous stationery forms are passed through the machine. For this purpose these forms are frequently perforated. It has been claimed for some of these methods that they increase output by 25 to 70 per cent, and, as the carbons are changed before becoming worn-out, they produce clearer and better copies.

These methods, although producing copies, belong to a more specialized field and are intended for advice notes or systems work, and are therefore not within the wider scope of document copying. Whilst the value of carbon copying with such methods is undoubtedly sound, the present widespread practice of making a number of carbon copies together with the document being typed requires more thought and consideration. There can now be little doubt that the present high cost of typing, contrasted with the economical method of reproduction by diazo paper from a translucent master, calls for some revision of the long-established practice in this connection. The alternative method of using a translucent master and its particular advantages and disadvantages will be discussed later.

THE N.C.R. PAPER

A paper which would appear to be a revolutionary development in the production of all business stationery is now available. Known as the N.C.R., which stands for No Carbon Required and also indicates its development by the National Cash Register Company, this new material eliminates the need for carbon paper when making copies.

The principle used in this paper is the interreaction of two chemical coatings which have been applied to the two surfaces of the paper.

The visible image is created when the two chemicals are brought together by pressure.

The paper is quite smear- and smudge-proof and is therefore clean to handle. The print produced by it consists of two colours. The first is the immediate blue colour which will slowly fade and be replaced by a green colour which gives reasonable permanency to the print. Owing to its relative newness the keeping life of N.C.R. paper over prolonged periods is not known. From laboratory and practical tests it would appear that under normal conditions it should last almost indefinitely. It must, however, be understood that since it contains dyes rather than pigments such as are found in carbon paper, it should not be used where absolute permanency is required until its possible keeping qualities have been assessed.

There are three types of N.C.R. paper available, these differing according to the method of their coating. The top or original sheet is back coated (C.B.), the intermediate sheets are coated front and back (C.F.B.) and the final sheet is front coated only (C.F.). The purpose of these three methods of coating will be obvious.

By using an H.B. pencil it is possible to obtain up to four copies or up to six copies by ballpoint pen. With a standard typewriter eight legible copies are possible and up to twelve may be obtained with an electric typewriter.

A serious disadvantage of this paper is that at the present time erasures cannot be made without undue defacement of the record. The top impression is the only one that can be corrected, and this requires pieces of protective material to be inserted throughout the whole set.

This non-erasability is, however, a safety feature in accounting and other business fields, and provides security against fraud.

The present cost of N.C.R. paper is from 10 to 20 per cent higher than the cost of ordinary paper and carbons. This additional cost is somewhat offset by the time saved in not having to interleave and remove the carbon paper, as is required by the normal method.

By the use of lithographic methods N.C.R. paper can be printed to produce forms and other documents. Owing to the clay coating on the front of the paper it will cause some pick-up on the blanket, necessitating occasional washing of the plate and blanket. The ink should also be thinned to the maximum amount the plate life will permit and the water run freely to reduce any tendency of the paper coating to cake on the blanket. By these methods successful printing can be expected for 2,500 or more impressions.

To allow only limited portions of the original record to appear on the carbon copy a colourless desensitizing ink is available which,

when applied, will prevent the development of the N.C.R. paper in that area. The presence of chemicals in the N.C.R. paper does not affect this material and does not decrease the life of the paper itself.

Many of the firms who deal with continuous and other forms of stationery are providing similar forms on N.C.R. paper for use in their machines.

AUTOSCRIPT SEALED CARBON PAPER

Autoscript is a carbon paper coated with a sealing compound. The carbon is therefore sealed in the paper and is not liberated until pressure is applied by typing or other means. By this material additional copies can be produced without the use of separate carbon papers. Autoscript is supplied in various tints; the colour or shade of the reverse side indicating the colour of the typed copy. It is available in black, red, green and blue.

When typing, plain paper is used for the top copy and the sealed carbons for all subsequent copies. The carbon copies produced by this method are of low contrast. Corrections are made by writing or typing above the error character.

The cost of Autoscript is about the same as that of interfold carbon set stationery. It is available in cut sheets or continuous form, and in various sizes. It is of German origin and is to be manufactured in this and other countries.

CHAPTER IV

THE TRANSLUCENT MASTER

THIS METHOD consists of typing on a sheet of translucent paper and producing copies by the dyeline process. The method is not entirely new, because translucent materials have long been used for preparing masters for use within the drawing office, but its widespread use as a means of office reproduction is a more recent innovation. The diazo paper which is used to produce the copies from these translucent masters is described in a later chapter.

The translucent master is normally prepared on a sheet of white detail paper which is translucent to ultra-violet light, the particular light source used in the diazo machines. This material is available in a variety of weights, ranging from a light to a heavy weight, the latter being used as ledger or statement cards in machine and manual accounting. Other types of paper may also be used, providing they are reasonably translucent and do not have excessive grain or fibres. Where slightly longer exposures during printing are not inconvenient, ordinary bank paper up to 11 lb. in weight, carbon copy paper or airmail can be used, since these are thin enough to reproduce on diazo paper in the printing machines designed for this material. However, as the special translucent materials used in this method are now widely available from paper manufacturers and dealers, and since their cost is no higher than that of normal paper, it is advisable to use the material which has been specially produced for this purpose.

The translucent master can be typed in any typewriter. Special ribbons are available for this purpose, and since these are able to give characters of great density they should always be used. These ribbons are available from all carbon manufacturers and also from the suppliers of diazo machines. An alternative method is to use a normal ribbon and, in addition, a sheet of carbon paper, preferably yellow or red, placed behind the translucent master but with the carbon in contact with the back of the sheet. The purpose of this method is to deposit a carbon layer on both sides of the sheet, thus creating an opaque image which will enable a good-quality print to

be made on diazo paper. The only disadvantage of this method is that errors must be corrected on both sides of the paper.

No particular skill is required to type or otherwise prepare these translucent masters. They can be readily corrected and, unlike other duplicating masters, corrections (or additional information) can be made at any period of their life. Being dry, they can be easily stored and require no cleaning after printing. Always available for re-use, they can be withdrawn from the store and reprinted with the minimum of time and expense.

This method of reproduction is not designed for long-run work, since by using sensitive paper it has a higher repetitive cost than the duplicating processes. It is more suitable for producing a limited number of copies from an unlimited number of masters. The number of copies it can economically provide is generally considered to be between that of the typewriter and the duplicating processes. It has, however, been found that, except where continuous stationery is used, the cost of inserting and later withdrawing both the carbon and copy sheets and also the time required to correct all errors on each carbon copy more than outweighs the cost of the diazo paper used with the translucent method.

In an examination made to estimate the increased amount of typing produced by the use of the translucent method, it was found that this was over 50 per cent. The test was conducted over a monthly period, the typists working alternate weeks on translucent masters and carbon papers. The economy given by this method is discussed in the following chapter.

Carbon copies are also made on flimsy paper; they are often difficult to read and sometimes not acceptable. The copies produced by diazo from a translucent master are all of equal quality and clarity.

Translucent masters can also be prepared by methods other than typing. The paper can be printed by offset or letterpress machines to create forms which may later be completed within the office or by the public. When only a few copies of these completed forms are required, the diazo process can produce them by the speediest and the most economical means.

When using duplicating or printing processes to prepare forms or pre-printed masters for this purpose, the ink used is of importance and is therefore discussed later.

A translucent master can also be prepared from special apparatus such as the punched-card tabulator, teleprinter and machines of a similar type which normally prepare only one or a very limited number of copies. By making a master on translucent paper, the reproduction of additional copies is a simple operation.

Manual methods can also be employed to create the masters but blue ink should be avoided unless it is not required to print, sometimes a particularly useful feature.

Another important use of this method is to meet requests for occasional copies which are required after the reproduction and distribution of the original demand. Occasional requests for copies of documents already distributed are one of the main problems in both reproduction and information departments. To meet such demands, it is normally necessary to print in excess of requirements and store the surplus copies against any request which may, or may not, be made at a later period. This method requires much storage space, often expensive and difficult to find in a large city. It also necessitates considerable clerical organization, together with lighting, heating and cleaning. A dry, translucent master stored against such requests can remove most of the difficulties associated with this problem. The envelope containing the master is withdrawn from the filing cabinet on receipt of a demand and the copies are immediately produced on the diazo machine. To do such work by the use of any duplicating machine would not be economical. Fitting a duplicating master to a machine, inking and running for a single, or a very few copies, would be time-consuming and expensive.

With the extended use of the translucent method and the increasing need for more storage space it has become common practice in some reproduction departments to create a new translucent master simultaneously with the duplicating master, either by direct typing or from the inked intermediate, using the duplicating process to provide the original demand and reserving the other master to meet the occasional copies as required.

The translucent master can also be conveniently sent through the post for subsequent duplication in another branch, factory or department. This is a limited application, but occasionally a useful one.

Translucencies have been used with unique and interesting applications in many countries. In Holland, patent specifications are printed by letterpress machines to meet the known requirements for distribution abroad and for internal use. When the required number of specifications has been printed, a sheet of translucent paper is then fed through the printing machine, thereby creating a master which will meet all later public demands when the small stock of printed specifications has been exhausted. The use of the more sensitive diazo paper is offset by the reduction in storage space and clerical and administrative costs. Similar methods are now used in this and other countries.

Printed forms, drafts, charts and similar documents printed on translucent paper are available in many countries. When these have been completed in the normal manner by black ink or pencil, they can be quickly and economically reproduced on diazo machines. Large industrial firms are now supplying representatives with order forms in this material. The reproduction of a few copies within the office from these forms is the simplest and cheapest method which can be employed.

In accounting and other forms of related office procedures the translucent master is being increasingly applied. Generally, the paper used in these methods is of a heavier weight, able to stand firmly in the normal type of holder. Where information is being frequently added to statements, or deletions made, the stronger material is ideal for the purpose. A copy of these documents can be readily produced at any given period by the small diazo machines.

From a careful survey of its wide scope, it would appear that a fuller appreciation of the possibilities of the translucent method will only serve to extend its use into other fields. Owing to the unlimited applications of the process, it is becoming more and more obvious that ultimately the diazo copier in the office will become as commonplace as the typewriter is today.

It is important to remember that in all reproduction work the greatest measure of economy is always best achieved when it is possible to prepare the original in a manner which allows its reproduction to be made immediately, without the need to create an intermediate master; consequently the minimum of expense is involved. For this reason, the practice should be encouraged of preparing all printed and typed documents on a translucent base and on one side only, so that whenever copies are required they can be obtained with the minimum of delay and cost. In any process (microfilm excepted) the cost of material is small in comparison with labour cost, hence the use of translucent masters, within the economic number they are designed to produce, is always an economical consideration.

The small diazo rotary machines designed for use in the office are particularly suitable for making copies speedily and economically. Where occasional copies only are required, the small non-rotary machines available for diazo printing are also suitable.

CHAPTER V

MATERIALS FOR USE WITH THE TRANSLUCENT MASTER

THE THREE chief methods of preparing translucent masters are by printing, typing and handwriting. Printing methods are used to prepare forms and similar documents. For this purpose, a printer's ink having a good dense carbon black should be used; blue inks are generally not satisfactory. It has been recommended that brown or red dyes should be added to the inks to provide the required opacity to the ultra-violet light. There are many excellent inks available and most ink manufacturers are fully aware of this requirement and are able to provide one suitable for this purpose. Firms who provide special stationery for use with diazo machines are also able to advise and help on any problem connected with the printing of translucent paper.

Typewriter ribbons are also specially made for use with translucent material. Most of the firms who specialize in ribbon manufacture have produced suitable ribbons for this purpose. No list is appended here because they are still in a state of development and each year a number of new or improved ribbons is added to the ever-growing list. Those intending to use these ribbons should write to the manufacturers or purchase such from the office suppliers. These can then be tested on the same sheet of translucent paper and a copy made on diazo material. The result will enable the selection of a suitable ribbon to be made.

Where only occasional translucent masters are typed the alternative method of backing with a special yellow, red or black carbon, as previously outlined, can be used.

The materials used for handwriting include writing ink, ballpoint pens, pens and pencils. The wide variety of material available and the lack of any standards in these materials often creates difficulties and produces unsatisfactory results.

It will be found, in general, that many writing inks contain a large proportion of blue dyestuff. As blue does not reproduce well on diazo paper, ink of this kind is very unsatisfactory. Some of the black

writing inks are good, particularly those of the waterproof or indian type. Many ballpoint pens are, however, unsuitable and, unless backed up with a black carbon paper, will not provide acceptable results.

The Rapidograph pen which uses a special indian ink is excellent for this purpose. Obtainable in many thicknesses it is able to give lines described as extra fine, fine, medium and broad.

It will be appreciated that the photocopying quality of handwritten documents will be materially affected by such factors as the width and the sharpness of the pencil points and by the style of handwriting. In this connection the degree of hardness of the pencil has some bearing on the point-retention quality, which is important. Following a test made with a large number of pencils, it was found that they differed considerably in their performance, and that, as may be expected, the greatest ultra-violet opacity was given by the softer pencils. These however wear down fairly quickly and therefore require sharpening more frequently. The test indicated that none of the pencils examined contained any special ultra-violet absorbents.

As a general guide when preparing translucent masters, it is preferable not to use a pencil harder than 2H; the softer grades will produce better photocopies. Pencil writing is normally less deliberate than draughtsman's line work and is therefore liable to produce a less satisfactory diazo copy, unless special care is taken in the choice of a suitable pencil or correct pressure is applied when writing. Usually pencil lines allow more than half the light falling on them to pass through to the dyeline paper, thus reducing the contrast of the image by this amount.

Experiments made with various writing and drawing materials, with the object of obtaining information regarding their opacity to ultra-violet light, and estimating the full contrast index which must follow from their use, have indicated the following factors:

	Ultra-violet opacity	Light Transmission
Black ink	100°	0
Typewriter ribbon (selected)	100°	0
Pencil line backed by carbon	100°	0
Direct positive (SH) paper	100°	0
Ordinary typing backed by carbon ..	80°	20°
Pencil 2B	80°	20°
Pencil 4H	50°	50°
Blue-black ink (not blotted)	50°	50°
Blue-black (blotted)	17°	83°
Ordinary typewriter ribbon	49°	51°
Rapidograph pen	100°	0

Before important documents are created or completed by writing materials which are generally used in the office a test should be made on a sheet of suitable translucent material, creating a line with every instrument or pencil to be used. It is essential when printing the copies on diazo paper that the minimum exposure be given which will create a copy having a slight over-all background deposit. This will indicate the maximum density the diazo paper will provide from the materials used.

The selection of suitable materials for preparing the translucent master is not difficult, and with the growing use of this technique more suitable inks, ribbons and other materials are being frequently introduced.

CHAPTER VI

THE RELATIVE ECONOMICS OF MAKING CARBON COPIES AND DIAZO COPIES

A PREVIOUS CHAPTER has outlined the techniques employed in producing diazo copies from a typed translucent master. The advantages claimed for this method in comparison with making carbon copies by typing are that collating and de-collating the carbon and the copy paper is avoided, and typing errors require correcting on the translucent copy only and not on each subsequent carbon copy. The influence of these two factors on the final cost of the copy is indicated in the chart on page 37.

In preparing this chart, the wages of both skills are calculated at 1d. per minute, which includes the appropriate allowance for the supervisor's time. This arbitrary figure will always be found useful when making calculations of this nature, and, considering the diversity of wages paid according to age and skill, is fair and reasonable. The chart does not include the cost of typing and correcting the top copy or the translucent master, since this would be similar in both instances.

It has been found by a careful examination in a large number of typing sections that the average time to collate six carbons and copy sheets and to de-collate these after typing was 62 sec., an average time of 10 sec. per carbon copy. The material cost for a quarto sheet of paper and the appropriate allowance for the carbon used is about 0·28d. It is therefore assumed that the total cost of material and collating time is approximately 0·4d. By using a carefully prepared document which outlined how the test should be made and stated the words to be corrected, it was estimated that the average time to correct an error was about 20 sec. This figure is a mean between the three main times involved in this work, viz. the time taken to correct an error whilst the copy is still in position, the error found by the checker which will require each carbon copy being placed separately through the typewriter for correction, and thirdly errors which consist of more than a single character and may require extensive correction, taking one or more minutes. It may occasionally happen

that corrections are so extensive that a re-typing is required. This expense would also be necessary when preparing a translucent master unless this sheet can be cut, allowing the missing paragraph to be inserted, a task which is not difficult with these masters.

It will be appreciated by all who have tried to estimate the error factor that it is extremely difficult to evaluate, particularly the last two considerations. From a wide correspondence on this matter and after numerous discussions with heads of many typing sections, it is felt that the average 20 sec. is the minimum time which could be allowed for this work, which may be double that figure.

The output of the diazo machine depends on the type of apparatus used, the sensitivity of the diazo paper and the size of copy. Machines are available able to produce over 1,000 copies per hour, and diazo papers have a range of sensitivities which could considerably affect output, according to the speed of paper used. Also, the larger-sized office machines will allow documents to be fed into the apparatus by the shorter dimensions, or two or more masters simultaneously, and will therefore produce an increased output over the smaller machines, which can only accommodate one master. To make a compromise between all these factors the output of the diazo machine has been calculated at a speed of 150 copies per hour. This is known to be a low average for the normal type of rotary office copier used for this purpose which, under certain conditions, can produce more than double that output. It will therefore be seen that the chart is heavily biased in favour of the traditional method of typing and preparing carbon copies, and can therefore be taken to indicate the maximum number of carbon copies which can be produced before it is economical to change over to the translucent master and diazo copies.

The cost of making a dyeline copy from a translucent master is determined by the cost of the sensitive paper, the developer, a small allowance for the lamp used and the time required to produce the copy. This has been estimated to be not more than 0·8d. per quarto sheet when taking into consideration the average discounts allowed on this type of paper. Assuming, therefore, that the cost of material and the labour required to collate and de-collate each carbon copy is 0·4d. and that the total cost of preparing a diazo copy is 0·8d., the following chart indicates the cost differences of these two methods.

It has also been estimated from an examination made to discover the increased output given by typists when preparing carbon copies by the traditional and the diazo methods that an increase of the order of more than 50 per cent was achieved where an average of six copies was required. In order to permit the measurement, all typing was recorded by an officer who maintained a record of each job

handled by each typist each day, showing the number of pages, the number of copies and the area of typing measured in square inches.

The experiment lasted for four periods of five successive working days. The first and third periods were devoted to typing on normal paper and carbon copies, the second and fourth periods to typing on translucencies with no copies except those prepared on diazo paper. While it is not possible to conclude from this short-term test precisely what permanent increases in output are assured, particularly when less than six copies are required, it is clear that good typists increase their output considerably and that the output of the slowest typists on translucencies is equal to the fastest typist on the normal method of making carbon copies.

The result of the test also indicated that typists found it a relief not to handle carbon papers, and that the appearance of the dyeline copies was satisfactory. The use of single-sided paper was not considered a drawback and was offset by the assurance that all copies were of equal quality and clarity, and did not require checking. Also, the translucent master when filed, provided a ready means of obtaining additional copies cheaply when required.

The economics given in the following chart will only apply where the diazo machine operator is fully employed.

QUARTO SIZE COPIES

(MATERIALS AND LABOUR)

TOTAL COST PER CARBON									TOTAL COST PER DIAZO					
No. of errors	*Cost of Material*	*Cost of each error*	1	2	3	4	5	6	1	2	3	4	5	6
0	·4		·4	·8	1·2	1·6	2·0	2·4	0·8	1·6	2·4	3·2	4·0	4·8
1	·4	·3	·7	1·4	2·1	2·8	3·5	4·2						
2	·4	·6	1·0	2·0	3·0	4·0	5·0	6·0						
3	·4	·9	1·3	2·6	3·9	5·2	6·5	7·8						
4	·4	1·2	1·6	3·2	4·8	6·4	8·0	9·6						
5	·4	1·5	1·9	3·8	5·7	7·6	9·5	11·4						
6	·4	1·8	2·2	4·4	6·6	8·8	11·0	13·2						
7	·4	2·1	2·5	5·0	7·5	10·0	12·5	15·0						

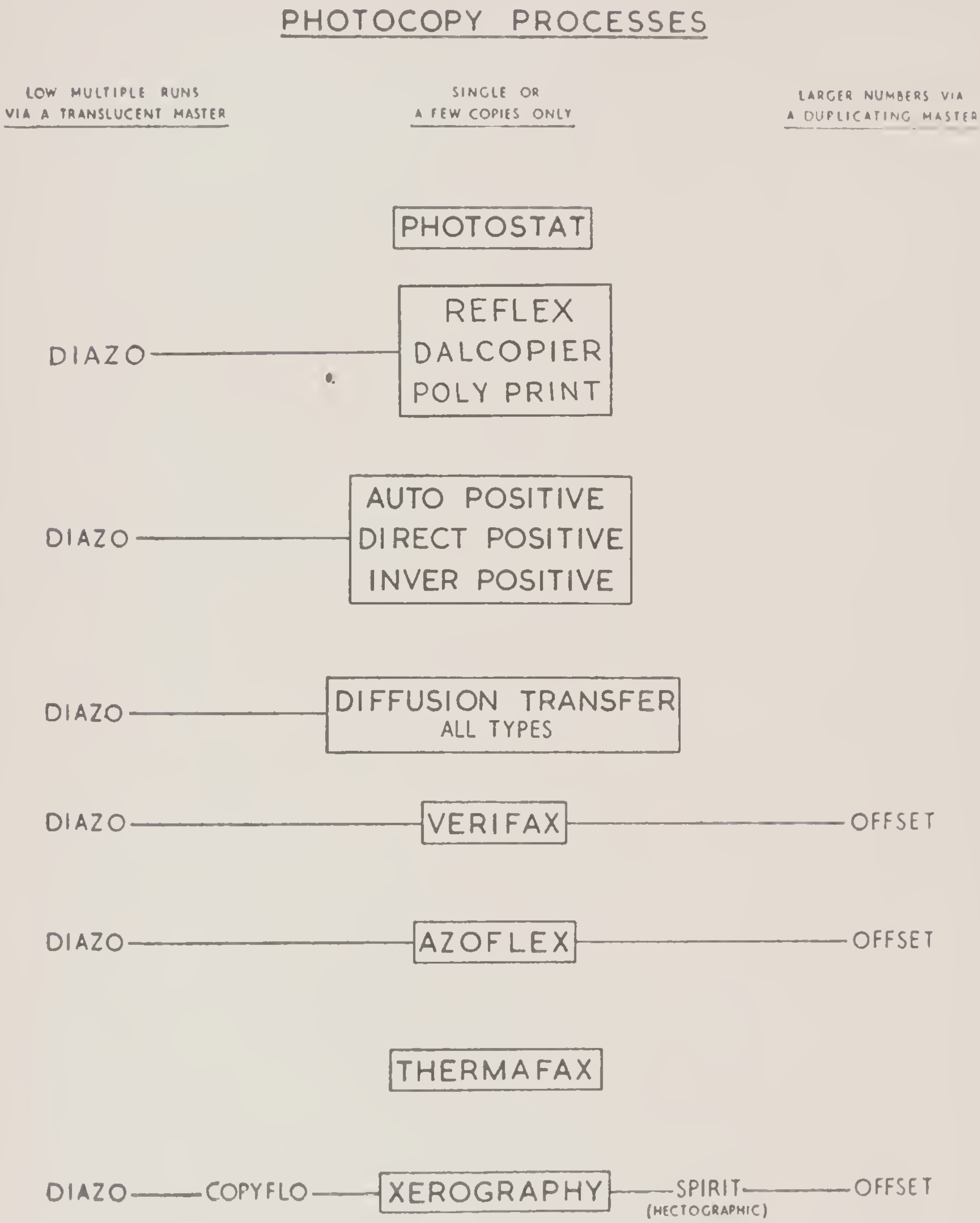


Photo-Copying Methods

The purpose of these processes is to make copies from originals already in an acceptable form. They are intended to provide one or a limited number of copies only or to make an intermediate master for larger numbers by using diazo paper or a plate for offset Lithography when a much larger number of copies is required.

PART TWO

CHAPTER VII

PHOTOCOPYING PROCESSES

THE PHOTOCOPYING processes are those which are generally designed to use sensitized materials and therefore to produce copies by the action of light on sensitive emulsion. However, recent developments in this growing field have brought to the photocopying range entirely new methods, some of which use sensitive material only to create the intermediate master, producing copies on unsensitized paper, and others which do not, at any stage of the process, employ photographically sensitized emulsions. Although some of these new processes have reduced the cost of making copies they have not disturbed the purpose for which such processes were evolved.

All these methods are designed to produce only a limited number of copies and from originals which are already in an acceptable form. Such processes can, of course, produce copies from any type of document, manually or mechanically prepared, but, apart from giving some increase in the contrast when copying weak originals, they are normally not able to improve the quality of the document being copied. It is therefore essential that they are used only to prepare copies from documents which are in a form suitable for direct reproduction. Their particular usefulness is in the copying of articles contained in various printed journals, typewritten and similar documents, including plans or drawings, of which only one or a few copies are required. They are not designed or intended to compete with the duplicating processes, but rather to meet entirely different requirements. The higher cost of the sensitized paper normally used in these methods limits the number of copies which can be economically prepared by them, but, when used within their limitations, they are economical, since they avoid the cost of typing and checking, an important factor with all duplicating processes. When it becomes necessary to type a document, owing to illegibility, numerous corrections or other causes, it is cheaper to prepare a duplicating master than to use photography (unless for specific reasons, it is better to use the translucent master technique). Another very useful feature of these processes, and in particular of some of

the newer ones, is that they are able by the use of small office apparatus to produce a positive copy of any document within a few seconds. This convenience enables office staff to freely use these methods, making them complementary to the typewriter and a most useful office aid.

Photocopying processes are also able to copy material which cannot be reproduced on the typewriter, such as drawings, half-tone and line illustrations, and some processes, for example Photostat and Xerography, can produce copies reduced or enlarged from the size of the original. Prints made by any of these processes do not require checking, a brief scrutiny only being necessary to note the clarity of the copy.

Also they are extensively used to prepare intermediate masters for use with other processes. Where the document has to be reproduced in large numbers and is already in an acceptable form such as letterpress material, books, etc., the preparation of a new master by these methods enables the final printing to be made by the offset or stencil processes and is extremely economical and satisfactory.

The general postwar developments in photocopying have been of three different types. The first method makes a translucent or transparent master from which additional copies are produced, normally on diazo material. The second, called transfer methods, creates a positive copy by transferring the exposed and developed image from an intermediate master to a receiving material. The third type is known as photo-electrical and makes copies by dry, electrostatic processes.

The materials used in the translucent intermediate method are usually a transparent diazo foil made by reflex printing, or a translucent paper on which a carbon image has been transferred, or a photographic paper which is able to give a direct positive copy by exposure and development. This paper is known as Autopositive, Inverpos or Directpos, according to the manufacturer, and is fully discussed in a later chapter. For greater convenience in office use, methods of processing have been devised which do not require the use of a darkened room with sinks, washing and drying apparatus. The new method is generally referred to as the semi-dry or stabilizing technique. The latest method uses only one solution for both developing and stabilizing and will produce a copy or intermediate master in a few seconds, using small office apparatus.

Diazo or dyeline papers which have long been used in the plan-copying processes are now widely employed in new and improved form to produce the final copy in a number of photocopying

processes. This type of paper is particularly suitable for these methods, since its low sensitivity allows it to be used in normal office lighting and, being considerably cheaper than silver halide paper, it enables copies to be produced more economically than is possible by using photographic paper entirely. The economic limits of the photocopying processes have therefore been extended to allow a greater number of copies to be produced before it becomes cheaper to use duplicating methods. Diazo paper can also be developed by dry or semi-dry methods in very simple apparatus and, since it requires no fixing or washing, can be used immediately it leaves the machine. Owing to their importance in the field of document copying, both the direct positive and diazo papers, together with the stabilizing techniques, are more fully discussed in a later chapter.

The transfer processes differ in their methods. The Diffusion transfer process is able to give one or perhaps two copies on chemically treated paper, but Verifax can produce up to six (or more) on uncoated paper. The Azoflex process incorporates a method of carbon transfer which may, in common with all transfer methods, be made directly on to opaque or translucent material.

In the photo-electrical methods the most important processes are Xerography, Electrofax and the Photronic Reproducer. The following brief résumé will indicate the main principles employed and the present differences between these processes.

Xerography employs a photoconductive selenium-coated plate as the photosensitive element. From this plate opaque copies and reproduction masters can be readily obtained. Electrofax is an electro-photographic method of printing on to paper which has received an electrostatic charge on its surface. The Photronic Reproducer creates an electrostatic image by projected light falling on a thin, metallic film which attracts vaporized ink to form a copy on unsensitized paper. The one factor which is common to all these methods is that, in addition to their other features, they can all produce copies from a continuously projected image, such as a roll of microfilm, on to paper.

Because all these methods are able to produce copies at high speed and low cost, their future in the wide range of available reproduction processes is assured. The tremendous progress they have made since their introduction a few years ago indicates the immense possibilities which can be expected from continued research and development.

The comparative costs of some of the photocopying processes and the relative economic limits are outlined in charts in Chapter XLV.

PHOTOCOPYING AND THE TYPIST

Since photocopying can relieve the typist of so much drudgery, it would appear that there is a need for some short document to indicate to senior typists, whose task it is to delegate work, the type of material suitable for photocopying. The directive should outline the techniques employed in document copying. A detailed description is not essential, since if there is more than one process employed in the section it will be the duty of the reproduction head to use the appropriate method or machine. Primarily, any such document on this subject should indicate the type of work suitable, enabling it to be selected and sent to the photocopying section.

The points which should be emphasized are those which have been previously outlined. To avoid directing unsuitable material to the photocopying section, it is necessary for some indication to be given of any colour which will not reproduce satisfactorily by the process used in the department. The chapter on 'Colour Response' will assist in this direction.

The limitations of size and the economical number the process can produce are both important and a small chart outlining these factors would be useful. It would seem appropriate to add some information concerning the making and printing of a translucent master. This would enable the senior typist to advise accordingly when work is suitable for this method. If samples of work produced by the photocopying methods employed in the department could be attached to the document, it would give the typist a visual example of the type of work done by each process. They could also be used as samples to indicate to executives the results obtained by photocopying.

It is considered important to emphasize to the typist that these methods are designed to assist her work and not to supersede it. Little co-operation can be expected if the typist feels that photocopying is intended to replace typing. She will assist more readily if convinced that it is an auxiliary and not a replacement. Few typists enjoy typing for its own sake and are therefore happy to co-operate in the use of other methods for making copies of work which, through lack of understanding, is wrongly sent to the typing pool.

CHAPTER VIII

REFLEX (SILVER HALIDE)

THE TERM 'REFLEX', when applied to a document-copying process, refers to a method of using photographic (silver halide) paper which produces a negative by reflection printing. The paper used in this process is often referred to as reflex paper. The reflex or reflection method of preparing the master has also been widely used in some of the newer processes, which do not use reflex paper; but the original method, which is extremely old, appears to have the prerogative of being known as the reflex process.

The particular purpose of the reflex principle is to enable an opaque or double-sided document to be copied. It gives a reversed-reading master which, when printed by direct transmission, will produce a positive copy. When the reflex principle is used with positive materials it will produce copies having black lettering on a white or transparent base, but these will always have reversed reading unless special adaptations of the process are used, for example the indirect reflex method in which the emulsion surface is facing the light source.

Briefly, the reflex method consists of placing a sheet of sensitive paper in contact with the original document having the emulsion face to the printed matter. An exposure is made by passing light through the back of the sensitive paper, with the result that the light will be absorbed where it strikes the dark lines of the original, but in it being reflected from the white area of the paper.

The sensitive paper is 'fogged' by the exposure, since light is passed through the sensitive emulsion, but where the light is reflected from the white portions of the original it produces an additional exposure on the reflex paper to that received where it is absorbed by the dark parts. On development the effect of the reflected light is sufficient to give on the contrasty reflex paper a much greater density, thus producing a negative in which the dark parts of the original appear white on a dark background.

The positive copy is produced by printing this negative in direct contact with another sheet of reflex paper. This two-stage method is

essential where a positive copy is required. It will also produce copies of good quality because there is the necessary contact between the printed surface and the document paper. It is therefore particularly suitable when copying documents which contain fine line detail.

To assist further in improving the quality when copying a badly faded or weak original by the reflex method, the exposing light can be filtered through a yellow screen which helps to eliminate the pattern of the paper base and gives a sharp, clear image.

Documents printed on both sides of a fairly thin or translucent paper, when copied by the reflex method, may give a distracting

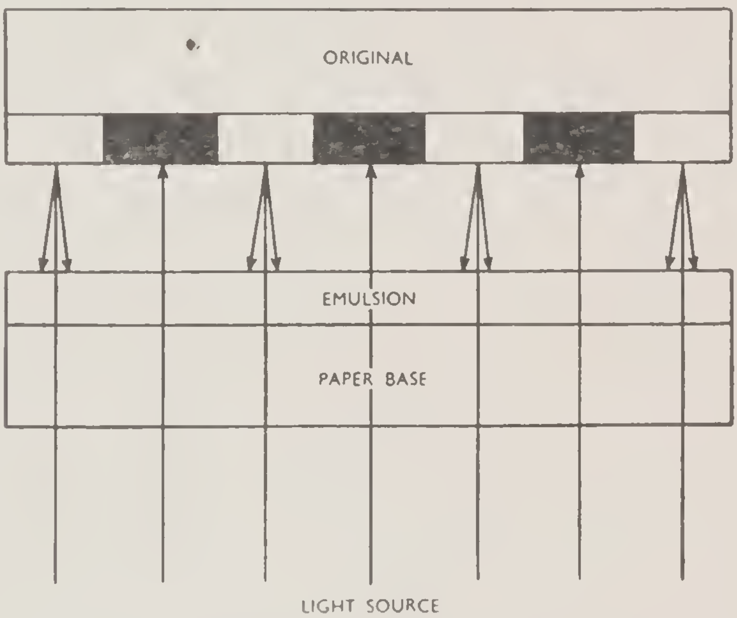


Fig. 1. Reflex principle. Gives reversed reading.

ghost image superimposed over the text. In these cases the original should be backed by a sheet of black paper or card to eliminate the unwanted image.

Single-sided documents which are on reasonably thin or on translucent paper can be printed directly by transmission and will produce a correct reading negative, similar to a Photostat negative. Where this direct method of printing is used, the sensitive paper is placed on the back of the original and light is passed through the face of the original.

An alternative method, particularly suitable for printing thick originals, is to place a sheet of smooth white paper in contact with the sensitive surface of the reflex paper and the back of the sensitive paper in contact with the face of the original, making the exposure through the back of the original.

It will be seen that in both these methods which provide a readable negative the thickness of a paper support is interposed between the actual printed character and the sensitive emulsion, and this will inevitably produce a slight loss of definition. Where the original does not contain extremely fine detail or is not unduly thick, this loss of definition is of little importance. These methods are especially economical when single copies only are required and when the directly readable negative is acceptable.

When printing from double-sided originals, a simple and effective method is to use a sheet of paper twice the size of the original and fold it with the emulsion side inward. The original is then inserted

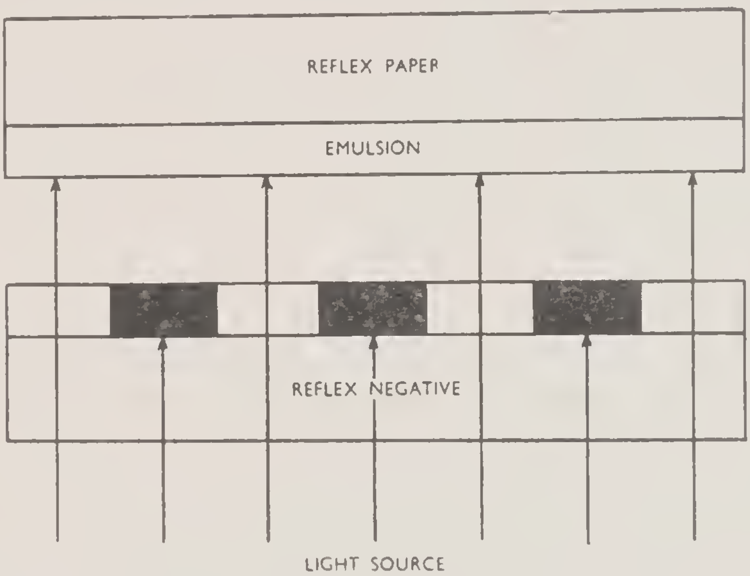


Fig. 2. Making a positive print from a reflex negative.

into this fold, allowing the two emulsion sides to contact the two sides of the document. In this position an exposure is made, one side being exposed first, then the other side. The processed print will therefore contain negatives of both sides of the original. When printed, this will produce a positive copy which, if folded emulsion side outwards and the inner surfaces pasted together, will give a double-sided copy of the original. This method is particularly useful for making copies of cards and similar documents. If the original is not entirely opaque, it will be necessary to use a sheet of black paper behind the side being exposed.

The reflex method has also been extensively used to prepare printing masters for use with other processes. Large printing boxes are available which enable it to make positive copies from plans, drawings and other originals. With the use of a translucent sensitive paper, linen or film the process can be used to create intermediary

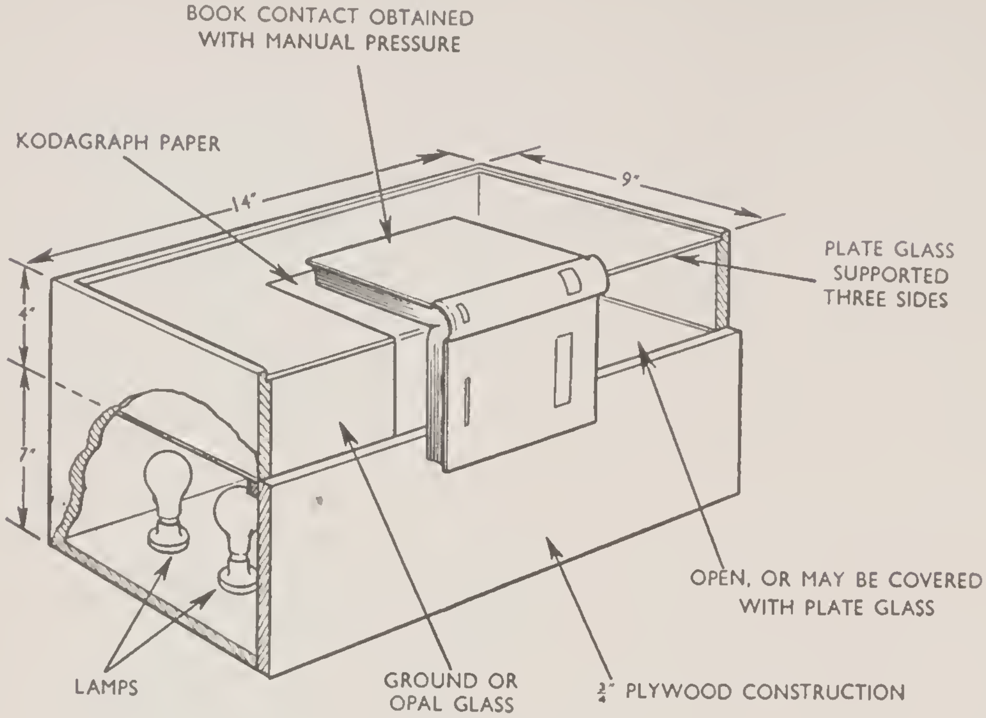


Fig. 3.

masters of increased contrast from a pencil or weak drawing, both opaque and translucent. These improved masters are printed by diazo or other methods giving copies which have a greater contrast than the original.

All methods using the reflex principle are non-optical and can only produce contact copies of the same size as the original. The reflex process is not suitable for the reproduction of photographic continuous-tone copies since the paper is unable to reproduce the full tonal range required, but it can give acceptable results from half-tone illustrations.

The apparatus used in this method is box-like in shape and fitted with internal lights for exposing the paper. A glass top and a pressure device are incorporated, which enable contact to be made between the original and the sensitive paper. The larger models have a vacuum pump for extracting the air from the pressure pad, thus giving complete contact over very large areas. Much of the newer apparatus incorporates a dual light source and is able to print both the reflex and the direct (silver) positive types of paper.

Apparatus is also available which is designed to enable a thick book to be printed. This apparatus usually has a strip of glass on one side of the printing box, allowing the spine of the book to be placed hard against the edge of the two glass surfaces. It is often possible to adapt some existing boxes by fitting a narrow sheet of

glass on the front of the apparatus. Contact is obtained by pressing manually on the hard binding of the book, the additional glass sheet allowing the light to penetrate the spine of the book and therefore exposing the whole surface. The illustration (fig. 3) will show this more clearly, and indicate how a simple box could be constructed if required.

Ancillary apparatus is also required for processing the negative and the prints. Processing can be done in the normal way, using the

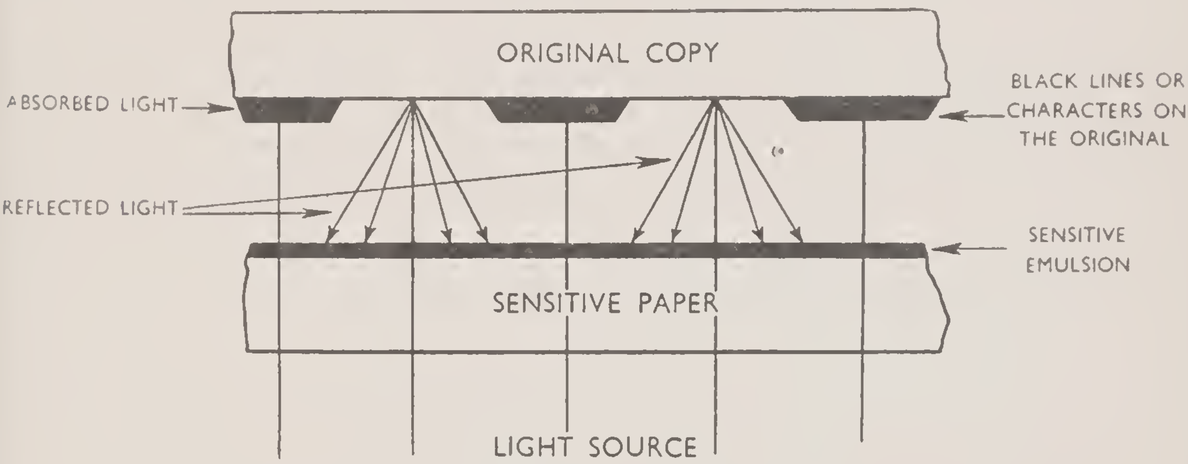


Fig. 4. The Reflex (Reflection) Principle. In practice the face of the original and the sensitive are in contact.

necessary developing and fixing solutions in trays, followed by washing and drying. The stabilizing technique can be used when permanent prints are not required, or speed is important.

A darkroom is not essential for the reflex process, but the paper, being sensitive to blue light, should be handled in very subdued daylight, or preferably tungsten light. Where the process is worked on a production basis or large sheets are being used, it is advisable to use a darkened room, illuminated by the pale yellow safe-lights supplied by the manufacturers for use with this paper.

The prints produced by the process are of good quality, free from error and may be produced with the minimum operational skill.

The process is suitable for copying any form of typescript, printed or drawn matter. It cannot reproduce colour but will give adequate rendering of most colours of normal density, with a slight weakness in both yellow and red.

Two methods belonging to the reflex process are now available for office use. Known as Dalcopier and Polyprint they use small apparatus, work in normal office lighting and with high speed processing are able to produce a negative and a positive print in about one minute. Both these methods are described in the appendices.

CHAPTER IX

PHOTOSTAT

THE WORD 'PHOTOSTAT' is a trade name applied to a particular type of equipment and also to the prints produced by this machine. The apparatus is essentially a large camera with a prismatic mirror attached to the lens. It accommodates a roll of sensitive paper 350 ft. long and up to 18 in. wide. The mirror, by reversing the image, produces a readable copy in both the negative and the print and also enables the copy-holder to be used in a horizontal position, thus saving space and giving greater speed of operation.

The document to be copied is placed in the copy-holder and illuminated by powerful lights, mercury, fluorescent or tungsten. After being exposed the sensitive paper is wound down, cut off and processed. A correct reading negative is thus produced having white letters on a black ground, which, when recopied on the Photostat machine, produces a positive copy of the original. Copies may be enlarged or reduced within the limitations of the machine, and graduated focusing scales enable this to be done mechanically.

The Photostat machine is available in two types, known as (1) pedestal and (2) wall type. Both machines take reels up to 18 in. wide. Documents up to 40 × 30 in. can be copied, but the largest size of print produced on either machine is 18 × 24 in., documents over this size being reduced to conform to the maximum size of print.

The pedestal type does not require a darkroom, since processing trays are attached to the camera enabling all operations to be conducted in average room lighting. After exposure the print is wound into the developing tray, where it is left for the appropriate time of development and is then removed, by hand, into the fixing tray. Finally the print is taken from the machine for washing and drying in separate apparatus. This model can also be fitted with special backs to hold photographic plates or films. Without the prism it can be used as a normal camera.

The wall type is designed for use in a darkroom. The front panel is attached to the darkroom wall and the sensitive paper is contained in a special holder, which is housed within the darkroom. The lens,

prism, lights and copy-holder are in front of the panel. The operator works in an undarkened room, but processing must be undertaken by normal photographic methods within the darkroom.

The final product, negative and positive, given by both machines is identical, but the wall type is capable of giving a considerably higher output since a staff of as many as four can be economically employed on each machine, where the required output is sufficient to justify it.

The photographic paper used with this apparatus gives an excellent degree of contrast. Various grades, weights and widths are available and all these can be accommodated in the machine. The paper is generally supplied in lengths of 350 ft. and is wound in rolls on a special spool with a leader of opaque paper attached to enable it to be fitted into the machine without spoiling any of the sensitive material.

In other countries, Photostat and other prismatic machines are available with a complete processing unit attached to the machine. After exposure the print is automatically passed through the apparatus, emerging completely processed and dry.

In America the use of a special reversal Autopositive type of paper has enabled the Photostat machine to produce, by direct exposure and development, a positive copy of the original.

The Siemens machine made in Germany is also a prismatic type of apparatus which is able, by using reversal paper and an extended processing procedure which reverses the print, to produce a positive copy from a positive original. The period of processing, including reversal, is about 8 min., the print emerging dry and ready for use. Prints may be passed into the processing apparatus at frequent intervals, a number being processed simultaneously.

The prints produced by the Photostat machine or other prismatic methods are of good quality. Weak prints or pencil drawings may frequently be improved in density and clarity, owing to the increased contrast given by this process. Copies are, however, generally more bulky than the original, particularly when double-sided documents are being copied, but thin papers are available to reduce this additional thickness.

The process is designed chiefly for document copying and is suitable for all types of originals. Colours may be photographed but can only be reproduced in monochrome. For copying photographs having continuous tones a special paper is available, which is able to produce the long gradation scale given by the normal photographic printing methods. This paper is obtainable in short lengths if required.

Special pre-fogging techniques may also be used, which will extend the apparent tonal range of some of the normal Photostat papers. This pre-fogging is done by placing a sheet of white blotting-paper over the original in the copy-holder and giving the sensitive paper a short exposure to this sheet.

The normal exposure is then given, resulting in some reduction in the contrast of the negative which, in turn, produces a softer result on the final positive copy. The pre-fogging technique is necessary only with the negative, the positive being produced in the normal manner. The degree of pre-fogging depends largely on the contrast of the original document; normally it is about one-fifth of the total exposure. Copies made by this method cannot claim to have the tonal gradation of prints produced on photographic paper, but tests have indicated that some improvement is given when using normal Photostat paper.

The Photostat process is particularly suitable for producing a limited number of copies from originals which are already in an acceptable form. The direct production of a positive-reading negative makes it very economical for single copying work, when such copies are acceptable.

Photostat copies are permanent provided the processing has been adequate.

A photocopying method known as Polyprint has recently been introduced by E. N. Mason of Colchester. It is essentially similar to the reflex process in that it produces a negative from which positive copies are made. The small and compact apparatus designed for this process enables the negative to be exposed in contact with the original. The negative is developed in one operation passing through both chemicals in a few seconds, emerging dry enough to be printed immediately.

The positive copies are made by transmission printing and developed in the same machine by using the same paper. They are of good contrast and quality. The two chemicals used have a long life and require renewing only on infrequent occasions. The cost of each sheet of paper is about 3½d.

CHAPTER X

DIRECT POSITIVE PAPERS

TWO PAPERS which are able to give a positive copy by direct exposure and development in a single stage are being widely used in the photocopying processes. Both of these were originally developed for drawing-office purposes, but their special qualities have extended their usefulness into the wider field of document copying. One of these papers belongs to the photographic (silver halide) group, the other is the familiar diazo paper which is so widely used in plan copying to prepare dyeline prints. Because of the tremendous importance in document copying of these papers, the following information may be of interest.

DIRECT POSITIVE (SILVER HALIDE)

This photographic paper has unusual characteristics. An unexposed sheet will develop completely black but an exposed or fogged sheet will develop white. It therefore yields by direct exposure and development a positive copy from a positive original. Normally supplied on a white base this paper has an extremely high contrast and colour sensitivity, being therefore an ideal material for copying originals which are of a low contrast. Of a lower sensitivity than the normal photographic papers, it can therefore be handled in subdued daylight or in ordinary electric room lighting, but fluorescent lighting should be avoided if possible.

The useful feature of this paper is that it allows a positive copy of good quality to be obtained by direct exposure from a translucent original, and thus eliminates the wasteful negative stage which is often necessary with other processes. In this method, originals which are on reasonably translucent material with writing on one side only are copied by placing the sensitive side of the direct positive material in contact with the back of the original and making the exposure by passing light through the front of the original. This will produce a positive copy. If the original is on a thick heavy paper there may be some slight loss of quality, owing to the printed matter of the

original and the sensitive paper not being in direct contact. An improved result may be obtained by laying the emulsion of the direct positive paper on a white paper sheet and the original face down on the back of the sensitive paper. The exposure is made through the back of the original.

Opaque originals are normally exposed by the reflex principle, thus providing a copy which is a mirror-reading positive. This method will provide an extremely good intermediate master, suitable for

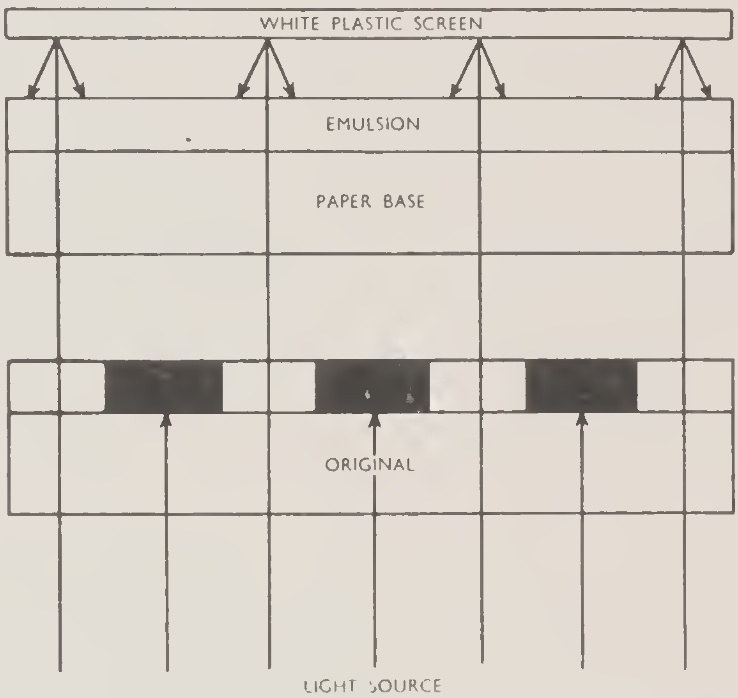


Fig. 5. Making a direct-positive print from thick, creased or non-uniform base.

printing either on the same paper or diazo material. The advantage given by a laterally reversed image intermediate is that when making the copies the image is in contact with the sensitive paper, and therefore maximum sharpness is given to the copy.

The direct positive paper can also be exposed by the indirect reflex principle, and by this method will produce a copy which although quite readable is lacking in contrast, owing to the grey tone of the background. It will be appreciated that when exposing by the indirect reflex method the sensitive emulsion of the direct positive paper is placed towards the light and the original being copied is laid face down on the back of the sensitive paper. By this method, the reflected light from the white parts of the original must pass through the base of the sensitive paper before striking the emulsion. This causes some diffusion of the image, because the

sensitive surface of the paper and the original are not in direct contact. To improve the results made under these conditions, a white plastic screen of a semi-transparent character has been introduced by the manufacturers. This screen is placed between the light and the sensitive emulsion, the exposure being made through it and also the normal yellow screen used in the process.

Tests have shown that although there is some loss of quality, the resulting print has a background which is whiter in tone and is therefore of improved appearance. This method is not recommended as a means of making intermediate masters for subsequent printing by diazo or on other material. It can, however, provide a most economical method of producing single positive copies from double-sided originals, when the quality given by this method is satisfactory.

The direct positive type of paper is also being widely used for making intermediates for plan copying on diazo paper. Weak, pencil, cracked or old originals can be printed on this material, to provide a new master of improved contrast and quality. In some countries, its use is so widespread that large machines have been designed which are able to expose, develop, fix and wash the material in one continuous operation within the same apparatus.

Special apparatus has been developed for exposing direct positive paper but it can also be printed in a reflex box or other machines. The normal reflex box designed for the reflex document copying paper would involve rather long exposures if used with this type of paper, but, with additional lights or lights of a higher wattage, it can be made suitable. As a rough guide, four No. 1 photoflood lamps will give an exposure of about 20 sec. at approximately 20 in. distance. Originals can also be copied by the use of a printing frame, requiring about 40 sec. exposure at 1 ft. from the photoflood lamp. The makers recommend that a screen should be used for both the reflex and transmission exposures. This screen varies in colour according to the make, though it is normally yellow, yellow-green.

Photo-printing machines designed for the dyeline and blue print processes can also be used for exposing the silver, direct-positive paper. The single carbon arc lamp may require the machine to be slowed down to 2 or 3 ft. per minute, and at these low speeds there is a tendency for the canvas to become jerky and for the material to slip on the cylinder, providing an uneven quality on the print. The twin arc is reasonably satisfactory if the two lights are correctly balanced to avoid uneven print quality. Mercury discharge lighting is ideal for making direct positive prints and is much faster than carbon arc. When the maximum speed of the machine is too slow for a correct exposure, the use of tracing paper between the light

source and the original is recommended. The most satisfactory form of lighting for making copies on this material in the photoprinting machine is the quartz tube, which provides results of an excellent quality.

It is recommended that when the moving canvas is in the form of separate narrow bands a piece of backing paper should be used behind the sensitive paper. For use with photocopying machines large screens are also available, which are bound at one end to facilitate feeding the prints through the continuous machine.

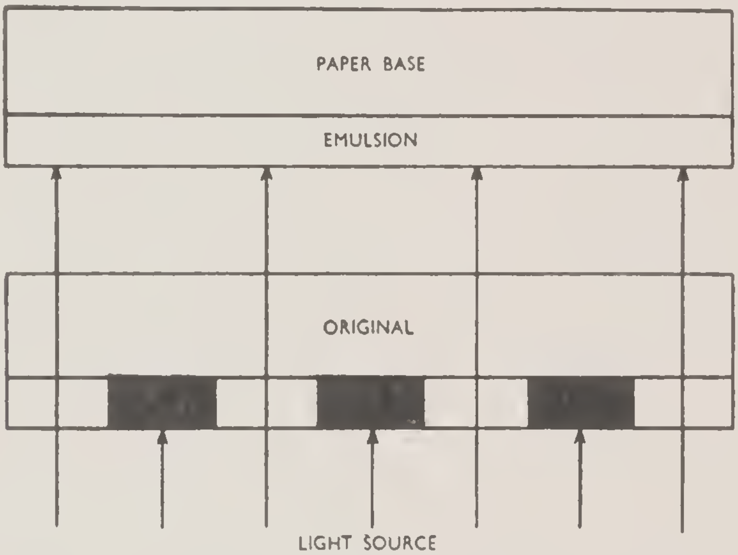


Fig. 6. Direct Method. Gives correct reading from single-sided original.

Methods of making papers transparent to decrease exposure time can also be used with papers which are not otherwise suitable for direct printing. A 10 per cent solution of Tri. Cresyl Phosphate * in turpentine or substitute (*not* spirit) applied to the back of an original with a swab of cotton wool will enable a higher printing speed to be used.

A 50 per cent solution will give greater translucency but will make the master somewhat sticky and this condition takes time to dry out. One application of the weaker solution will be satisfactory for about 50 copies, the heat of the printing machine causing gradual evaporation of the chemical. A solution of medicinal paraffin or petrol could also be used. A number of proprietary liquids are also available, some of these keeping the print translucent over long periods.

If turpentine is applied to the back of an old drawing it will remove the creases and some of the opacity. Since the application of turpentine does not show after printing it is particularly useful for originals which must be returned in the same condition as they were received.

* This chemical is very toxic and should not be used in a closed room.

The direct positive type of paper can be processed by the usual developing, fixing, washing and drying methods, as used with all photographic papers. This method is recommended where the master or print is required to remain in good condition over an extremely long period. The fixation of the print and its subsequent washing determine to a large extent the future file life of the paper and these steps in processing should be undertaken with care and thoroughness if permanency is required.

The stabilizing technique, either block or machine, can also be used when the copy is required for a few years only. This method is discussed in a later chapter.

Kodak Ltd. have recently introduced a direct positive paper which can be developed and stabilized in one solution only. This processing technique gives a brownish line which is opaque to ultra-violet light. It therefore provides a good intermediate master for making subsequent copies on diazo paper. A small machine for processing the material in this solution is available which completes the operation in about 20 sec. It is able to develop the lightweight paper which is particularly suitable for subsequent printing. Its introduction will do much to encourage an even wider use of direct positive paper for preparing an intermediate master, for use with diazo materials.

DIAZO PAPER

Diazo paper is a positive printing paper which, by direct exposure and development, will yield a positive print from an original having opaque lines on a translucent or transparent base. The light-sensitive chemical compounds present in this material are known as diazonium salts, a name which is usually abbreviated for usage to diazo. The image on the diazo print consists of dyed paper fibres, and for this reason they are frequently referred to as dyeline prints.

It is a general characteristic of the diazo salts that when exposed to ultra-violet light they will decompose, but where the coating has been protected from the light by a line of good density they remain active, and will couple with ammonia gas or a liquid developer to form a dye image. The choice of the diazonium salts and the coupler used will determine the final colour of the dye image, which can be of almost any colour. It will therefore be readily seen that if a diazo-coated paper is exposed in contact with a translucent original on which pencil, ink, printed, typed or photographically prepared lines have been made, the portions struck by the light of the photo-copying machine will turn white but those protected by the opaque lines will, by development, couple to form a line of azo dye. There-

fore, as with all positive papers, insufficient exposure will produce a print having a dark background, whereas over-exposure, although giving a white background, will reduce the density of the line image giving a print of low contrast and poor quality. To obtain good quality results it is therefore obvious that correct exposure is essential, preferably the minimum which will give a slight veiling of the background but having full density of line.

Since diazo is extremely sensitive to ultra-violet light, the lines created on the masters should have great ultra-violet opacity. The difference between the actinic and the visual density needs to be emphasized since the density required is one which is opaque to the ultra-violet light used in the printing machine. Thus a blue line which may appear dense to the eye may have little or no printing density. Yellow, neutral blacks and red will have the greatest light resistance or filtering action and give the maximum density in the final print. For this reason, when a translucent master is being prepared on a typewriter the ribbon chosen should be able to provide an image deposit having a strong ultra-violet opacity. Pencils, inks and other materials used for the preparation of the translucent master should also be carefully chosen for this characteristic. The aim should be towards a dense, clean, sharp line which is actinically opaque to ultra-violet radiation and a base material which is as actinically transparent as possible.

The ultra-violet translucency of the master base is the determining factor in the exposure of diazo paper. Exposure should be just sufficient to destroy the diazo compounds in the clear areas, leaving the protected line unaffected by light and therefore able to produce, by development, a line of good density.

Contrast in the final print is also determined to some extent by the type of sensitive material used. Broadly speaking, the slower-speed printing papers will give a greater maximum density than the faster printing papers, the general rule being the greater the speed the lower the maximum contrast given.

To provide even greater contrast when required special contrasty types of diazo paper have been introduced by some manufacturers. These papers are generally slower than the normal diazo paper and will therefore require an increased exposure, with reduced output. They do, however, produce a result having greater contrast and enhanced appearance.

In recent years the quality of diazo paper has been considerably improved, and applied experimentation and research continue to improve its colour, line fastness and keeping qualities. These developments have made the paper particularly suitable for use in

document copying and it is now extensively used to prepare the final copy in those processes which employ translucent master techniques.

The keeping qualities of diazo paper are variable, but methods of measuring and classifying these characteristics are in the process of being formulated in order that the expectancy of life, both before and after exposure, may be known. An examination of these factors has indicated that diazo paper is not as fugitive as is generally

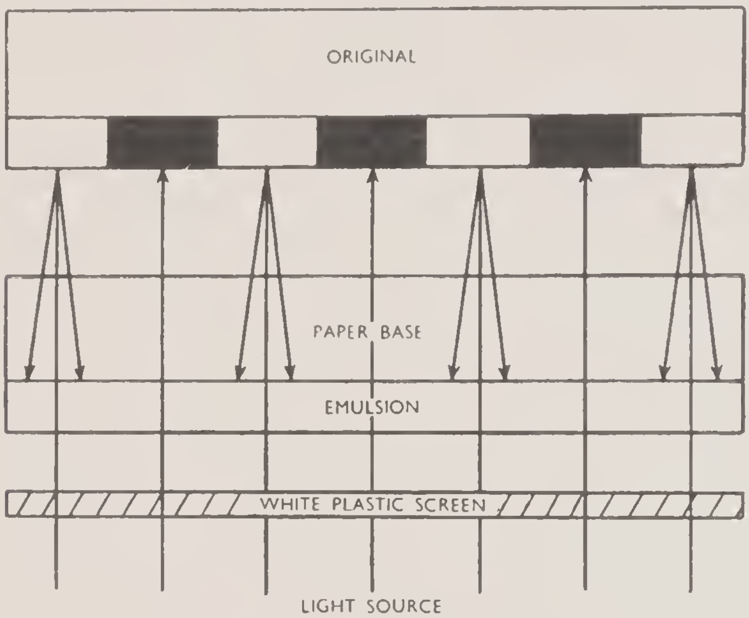


Fig. 7. Indirect Reflex Method. Gives correct reading from double-sided original.

believed. Contained in files for over thirty years this type of paper has remained in good condition, with every indication that it would be readable for double that period.

Much is being done by the manufacturers to extend the shelf life of dyeline materials. Whilst all diazo compounds are unstable and gradually decompose after manufacture, this decomposition can be considerably retarded by modern methods of manufacture and packing which coat, dry, wrap and seal the diazo rolls or packets under controlled humidity conditions. However, since diazo paper has a short shelf life, it should not be kept in storage over long periods. All manufacturers will deliver this paper at monthly intervals if required. The use of a cabinet with a base tray containing silica gel will help preserve the shelf life of diazo paper, and is particularly useful for packets which have been opened and therefore exposed to air.

The file life of diazo is determined to some extent by the type of the developer used and by the image quality of the copy which is filed.

Papers which use acid developers remain, as a general rule, without background discoloration over longer periods than those employing development in an alkaline state.

It is also considered that the fast papers have a longer file life than the slower and more contrasty type. Background discoloration, which occurs in diazo paper after many years of storage, should be distinguished from line fading. Discoloration may lower the contrast of the copy but the dyeline image will still retain its original strength. This background discoloration is not unduly serious, since generally it is retarded with time and still leaves the copy in a readable condition.

Recent developments in the range of diazo materials have produced papers which have a tonal range approximating that of silver halide paper. The tonal range, although somewhat more restricted than that of photographic papers, does enable diazo prints to be produced from a continuous-tone master. Such prints would be useful for inclusion in reports, or other documents where illustrations are required and when the number of copies to be produced does not justify the preparation of these illustrations by the more expensive half-tone process. Where the tonal range of the original cannot be accommodated on the restricted range of the diazo continuous-tone paper, the positive transparent master could be developed to a reduced contrast, or other means used to lower the gradation of this printing master.

Experiments made by using the Kodak Magenta Screen have indicated that this method can produce extremely good results on diazo paper. The method is fully outlined in chapter 49.

Diazo paper is also available which is able to produce by direct exposure and development with ammonia gas a two-tone copy from one master. The principle of this process is quite simple. Where no light is able to penetrate the lines of the original, a line of one colour will result, and where light partially penetrates another colour line will be created. It will be seen that the method is dependent upon the difference in opacity to light of the lines on the original tracing.

The two-colour diazo paper provides a useful and simple means of giving visual differentiation between any two parts of a print and is particularly useful where such distinction is required. Care must be taken in the preparation of the master however, to provide lines of the correct opacity for each colour.

Diazo paper is yet in its infancy. Continued research and development is bringing to this range of material new and fascinating achievements which are widening its horizon and extending its usefulness into other fields.

CHAPTER XI

PROCESSING TECHNIQUES

STABILIZATION

THE USUAL METHOD of making a photographic print permanent is to follow development by fixation in a solution of thiosulphate of soda, generally known as hypo. This process converts the unexposed silver halide to a soluble salt which can be removed by washing in water.

To conform more closely to office practice, methods of semi-dry processing are now being used which substitute for the familiar fixing solution a liquid called a stabilizer. The application of this stabilizing fluid renders the image relatively inert and therefore may be defined as fixing without washing. The method is effective where speed is essential in the preparation of an intermediate master or for making copies when the photographic record is not expected to be retained over long periods.

There are three ways in which this technique may be used. The first is by immersing the developed print in the stabilizer. This method must be followed by a brief rinse in water to prevent the stabilizer chemicals crystallizing on the surface of the print. The second method utilizes manual surface application for both the development and the stabilization of the print. Following a brief application of the developing and stabilizing solutions, the print is dried by blotting-paper or other absorbent material without rinsing or washing. The third method also utilizes surface application, by means of a small machine.

The stabilization method is designed to eliminate washing and the surface application of the chemicals with which this is achieved makes it particularly useful because a print can be prepared very rapidly. It is also useful where running water is not available or may be undesirable, e.g. in the office. Stabilizing techniques are intended for preparing photographic masters or prints where long-keeping qualities are not required, or where slight blemishes which may appear on ageing would not be of importance.

METHODS OF STABILIZATION

The original method of stabilization, which is still widely used, is the porous-block technique. This is a flat block of porous material having containers for the two solutions used.

Following exposure, the paper is laid upon the block face upwards, and by the aid of a squeegee it is first coated with the developing solution, followed by a coating with the stabilizing chemical. In the initial stages the print may have a tendency to curl and is therefore held in position by a rubber-tipped stick, or other means. The time of development is about 20 to 30 sec. for the direct positive type of paper and 45 to 60 sec. for the normal reflex paper. The stabilizer should be applied for not less than 30 sec., otherwise there is a danger of subsequent staining. The processed print, after being placed between sheets of Fotonic or other smooth blotting-paper, will be dry enough for making subsequent copies or for filing.

The principle of this method is that the surplus chemicals are absorbed by the porous block, thus preventing them from penetrating the back of the print and therefore the fibres of the paper. As the emulsion coatings will prevent penetration from the surface, this leaves the print free of injurious chemicals and avoids the necessity to wash it at a later stage.

Porous blocks specially prepared for this method can be purchased from a number of firms. Almost any kind of porous material will be satisfactory, if it is not too coarse.

Any block will eventually become stained and choked by continuous use and should therefore be occasionally soaked overnight or washed in water, allowing the pressure of water to exert itself against the surface of the block. It should then be drained and allowed to dry out partially before being used again.

Small machines are also available which are able to develop and stabilize prints in one continuous operation. If two exposed sheets are placed together with the sensitive emulsions outward they can be passed through these machines, receiving only a surface coating of the solution. All these machines considerably speed up the process of making both masters and prints. They are simple to operate and sparing in their use of chemicals. Where the quantity of work justifies their use, the time and labour they save in this operation should make them economical.

PERMANENCY OF STABILIZED PRINTS

Copies prepared by the stabilization method are not permanent. They should, however, show little change in three to five years if

they are filed in a cool, dry atmosphere. Beyond this period they may show signs of stain, which will grow progressively darker with time. Prints made by this method can, however, always be made permanent if required by simply immersing them in any normal fixing-bath and giving the usual period of fixation and washing. This method is effective at any time subsequent to the original stabilization.

WET PROCESSING METHODS

As the stabilized print produced by these methods is not permanent it is therefore necessary, for archival and other purposes, to wet-process in the usual manner. The essential steps in this method are developing, rinsing, fixing, washing and drying. The size of the dishes required will be chiefly determined by the largest-size prints processed in quantity. Porcelain sinks are suitable for this work, but are somewhat expensive to install. The self-contained unit type of trays, similar to those sold by E. N. Mason of Colchester, are more easily installed, although water and drainage will be required if they are to be used frequently. Occasional large prints can be developed by folding the paper with the emulsion side outwards and turning the print over at intervals in the developing solution. Kodak and other manufacturers supply large dishes made of lightweight wood. These are excellent for occasional use and are easily stored when not required.

It is now common practice to install sinks in the centre of the room, allowing printing apparatus to be placed along the walls on either side and so minimizing movement from the apparatus to the processing solutions, thereby saving time and reducing fatigue. Where the apparatus is of a large size, the processing trays may be more conveniently placed near the wall, unless the room is an exceptionally large one. A sheet of plate glass, or preferably plastic material, placed in a nearly upright position behind each tray will conserve chemicals. The print, after development, is laid on this and squeegeed, the developing solution being returned to the tray. In this semi-dry condition it is then placed in the fixing solution, thereby conveying the minimum amount of developer and thus saving the fixer from early contamination by this chemical. The same procedure is followed for fixing and washing, it being most important at the last stage to remove all the surplus water from the print and save the drying machine from becoming unduly wet. Otherwise it will necessitate passing the prints twice through the machine or, at frequent intervals, waiting for the heat to dry the blanket in order that the prints may be dried by one rotation of the drum.

The present practice of using packeted powders or bottled solutions has much to commend it. The developing powders recommended by the manufacturers are generally the ones most suitable for their paper. It is usually more convenient to mix a large quantity of this solution, and if it is stored in well-stoppered bottles, away from the light, or in brown bottles it will keep for many weeks. It is important to keep the bottles full of solution, otherwise the air will assist deterioration. For this reason, the bottles should be of a convenient size to allow the whole contents to be used at one session.

It is important to follow closely the instructions for mixing the developer. The temperature of the water and the manner and sequence in which the chemicals are dissolved, together with the type of container used, are important factors to be carefully observed. It is particularly important to dissolve each chemical before adding the next and, after the final addition of the water, to thoroughly mix the solution before it is decanted into bottles. Where staff desire to mix their own chemicals, the formulae are readily available, usually being contained on the instruction leaflet. The paper manufacturer is anxious that his product will give the best possible result. To this end, much research and experimentation has been made to enable him to advise correctly on this matter. In some instances, particularly with the photomechanical materials, it is essential that these instructions be followed closely if satisfactory results are to be obtained.

After development prints may be rinsed in a stop bath, consisting of a weak solution of acid. Its purpose is to stop development and avoid stains by neutralizing the alkalinity of the developer on the print, and so prolong the effective life of the fixing bath.

The fixing solution is important, and correct fixation, followed by a thorough wash, is essential if the print is to be kept over a long period. The length of fixation is also important if the print is to be made permanent, but over-fixation will result in some loss of quality. Prints should be moved frequently in the fixing bath, otherwise complete fixation cannot be achieved.

The action of the fixing bath is to remove the unexposed silver from the prints. By use the solution becomes charged with silver salts. Any sign of milkiness will indicate that it has reached exhaustion and should therefore be discarded. The addition of fresh hypo will not make the bath suitable for producing permanent prints unless the silver has been first removed.

Adequate washing can be obtained in about thirty minutes, providing the prints are constantly moved and agitated in clean water. It is extremely important to fix adequately, and to keep the

prints moving and separated during washing if permanency is required.

Prints may be allowed to dry naturally. The surplus water should be removed and the print laid on a rack covered with cheese-cloth, or photographic blotting-paper. They will dry more flatly this way than by hanging.

Heated dryers are perhaps the most satisfactory, and where much work is done the rotary type is essential. When using these machines for urgent work which has been inadequately washed, the print should be sandwiched between two sheets of smooth blotting-paper, to avoid hypo contaminating the drying belt and transferring itself to other prints.

It is also important to allow the belt to revolve for at least five minutes after the heat has been cut off. The brown, scorched belts so frequently seen on drying machines are the result of switching off the machine and the heaters together, allowing the hot drum to scorch the belt.

Chemical stains on the hand can be kept to a minimum by careful working. Rubber gloves can be worn but are often inconvenient, particularly with large prints. When stains do occur, they can be removed by cleaners or removing solutions. These are sold by all the large manufacturers, or the formulae are given in their literature on this subject. It is advisable, where possible, to fill the pores of the skin with a barrier cream before commencing work. This will assist in preventing stains, which are always objectionable, particularly to female employees.

CHAPTER XII

DIAZO METHODS

AZOFLEX

ORIGINALLY INTRODUCED in Holland by Van der Grinten and distributed by them under the name of OCÉ, this process is now available in this country, where it is called Azoflex. It follows the procedure used by some other document-copying processes of first creating a translucent printing master, from which copies are made on diazo paper. This translucent master can be made by two methods which differ considerably, both in principle and operation. The original method makes a positive master on material known as Reflex Foil, which is a diazo-coated, transparent film. This foil is then used as a printing master for making copies on diazo paper. It will therefore be seen that this method employs diazo-sensitive materials throughout the entire process.

The alternative method of making a printing master is by transferring a positive carbon image on to an opaque or translucent sheet, the latter also being used for making copies on diazo paper.

The material known as Reflex Foil is a translucent film containing a finely dotted screen, which enables it to be exposed by the reflex method when making a master from an opaque original. The screen in the foil acts as a barrier to the incident light and prevents it from destroying the image. It contains about 15,000 apertures per square cm. and occupies about 25 per cent of the foil.

After exposure, this screen is removed by a simple stripping device and the foil is then passed through the developing apparatus, emerging virtually dry and ready for use. In its completed state the Reflex Foil is transparent, with brownish lines of little visual density. These lines, however, have a strong actinic resistance to the ultraviolet light used in the printing apparatus and are therefore able to produce diazo prints of good quality.

The material known as Transfer Foil, which is used in the transfer method, contains a mixture of carbon black and diazo. This coating is water-soluble, but is rendered insoluble where the printing light

The transfer foil consists of a film carrying on one side a fine black screen and a diazo colloid layer. This layer will become adhesive when moistened with water, losing this property by exposure. When making a reflex copy the transfer foil is in contact with the original.

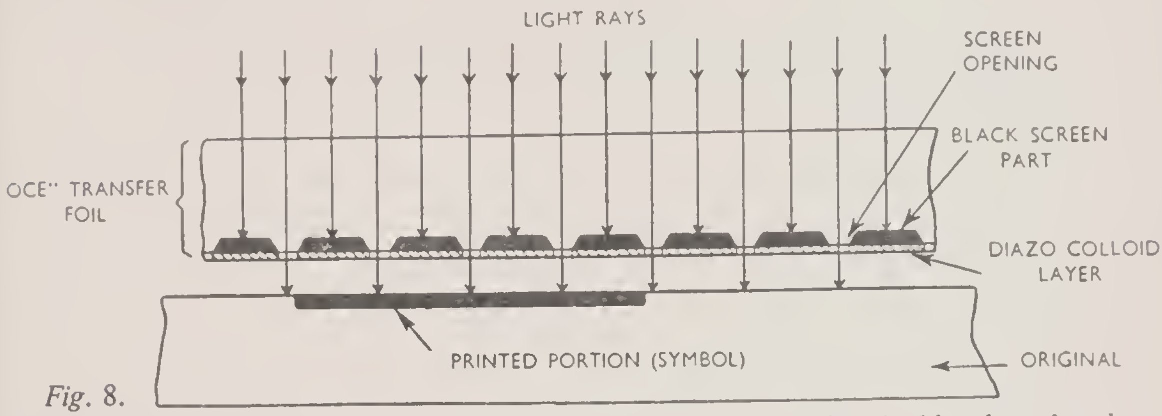


Fig. 8.

The light reaches the original via the screen openings, being absorbed by the printed portions and reflected by the non printed portions reaching the diazo colloid layer underneath the black screen parts. Thus only the portions of the diazo colloid layer which are between the printed portions of the original and the screen parts remain unexposed and therefore adhesive.

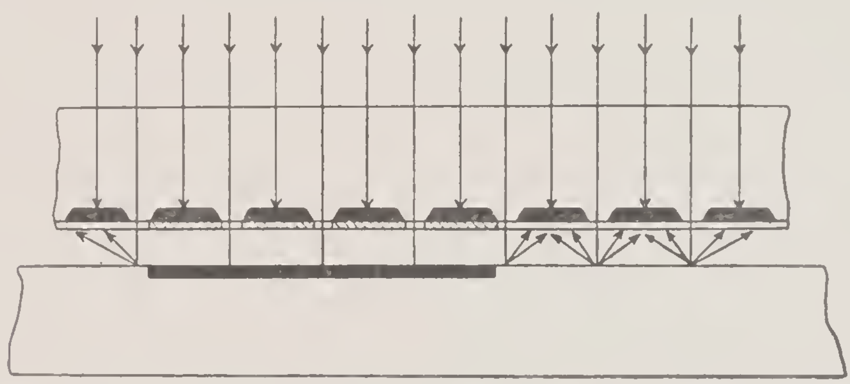


Fig. 9.

The exposed transfer roll is moistened with water and then pressed against a sheet of white paper or other receiving material. The unexposed adhesive portions of the colloid layer adhere to the receiving surface when separated from the foil.

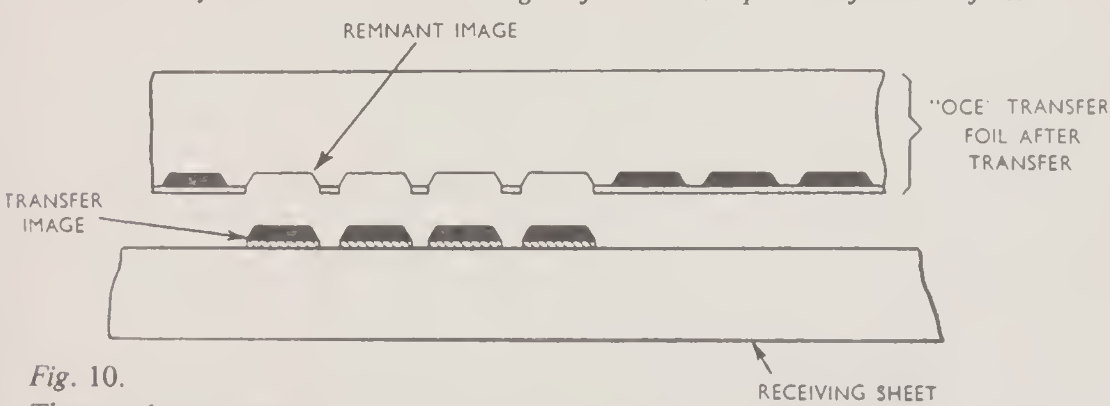


Fig. 10.

Thus on the receiving sheet a black positive transfer copy of the original is obtained while a negative remnant image remains in the foil. The transferred image consists of carbon which is permanent.

Permission Ilford Ltd.

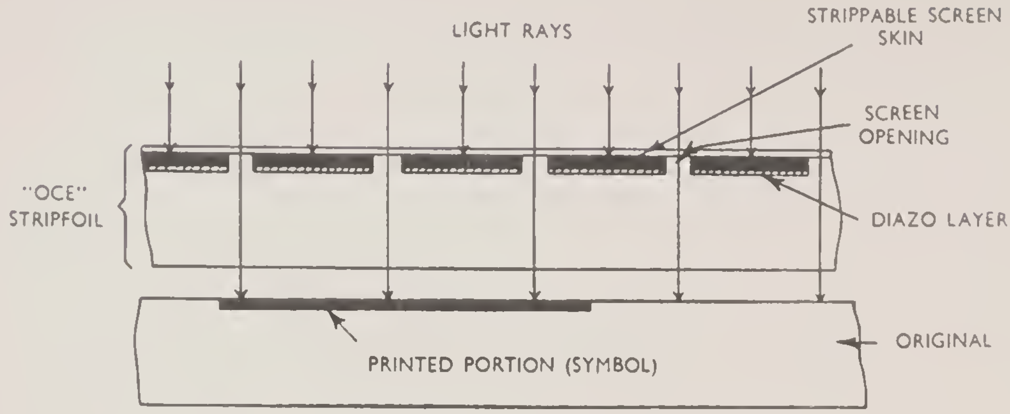


Fig. 11. The start of the exposure.

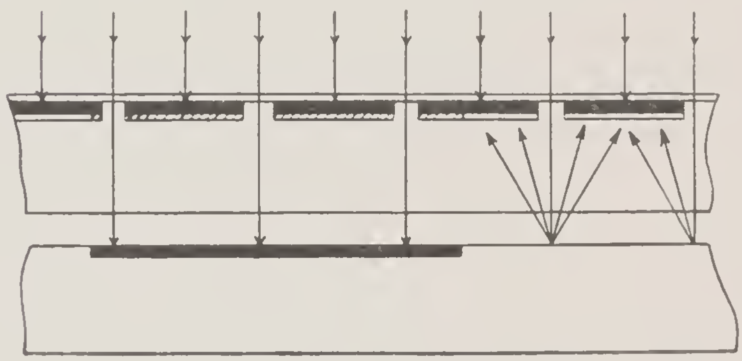


Fig. 12. The end of the exposure.

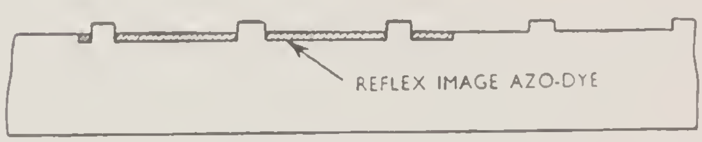


Fig. 13. After stripping and development.

falls upon it. Transfer depends upon the water solubility of the image where the light has not affected it. This material is exposed by the reflex principle. The light passing through the screen apertures is reflected from the white parts of the original and destroys the diazo coating.

The Transfer Foil is then placed with the screen diazo side towards the receiving material, which may be either opaque or translucent paper, a lithographic plate or any flexible sheet having a suitable surface. Transfer is achieved by passing the exposed foil together

with the transfer sheet in apparatus containing only water. The sheets are finally brought together between heavy pressure rollers, but are immediately peeled apart as they emerge, providing a foil negative and a positive copy with an image of dense carbon black, which has been physically transferred to it from the foil. As no developer or other chemicals are used in the transfer process the copy can be used almost immediately.

As the negative foil cannot be used a second time it is usually discarded. Single copies are made by transferring the image on to opaque paper. Multiple copies can be obtained by repeating the transfer process, but a new foil must be exposed for each transfer. It is therefore more economical to transfer an image on to a translucent sheet and make copies from this master on diazo paper. Where large numbers are required the transfer should be made on to a lithographic plate and copies produced by the offset process.

Where double-sided copies are required they can be created by the two types of masters used in this method. With the Reflex Foil, two films are used to expose an image on each side of diazo paper sensitized on both surfaces. The transfer method can be employed to transfer an image on to each side of an opaque sheet, or, by making translucent transfer sheets, to create a double-sided image in the same way as Reflex Foil.

The use of carbon black, which is of the highest visual density, produces an opaque copy of extremely good quality. It will also create a printing master in which the lines are opaque to light and is therefore particularly suitable for diazo printing. The line can be readily erased. The life and durability of the image made by the carbon transfer method is normally limited only by the base of the receiving material.

Azoflex apparatus is available in a wide range, which includes small, non-rotary machines for making masters from books and also fast rotary apparatus working from single sheets. A machine is also available which is able to produce a predetermined number of copies, cutting them from a roll of diazo paper. The apparatus is specially suitable when large numbers of masters are created and from which only a limited number of copies is required. Where the volume of work can justify a machine of this type, the large output produced with a minimum of staff makes it particularly economical.

The copies produced by both screen reflectography and the transfer foil method are of good quality. The translucent masters produced by both methods can be stored and used again as required. Although these are a little more expensive than some of the intermediate masters produced by the other photocopying processes they are,

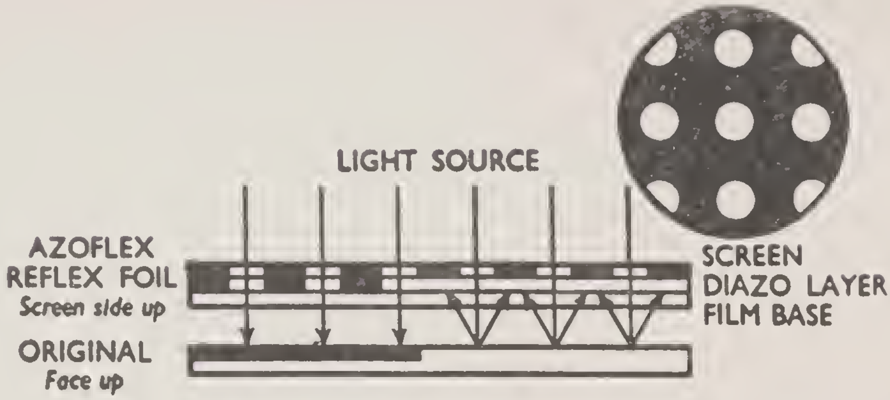


Fig. 14. Copying an opaque original using Azoflex reflex foil.

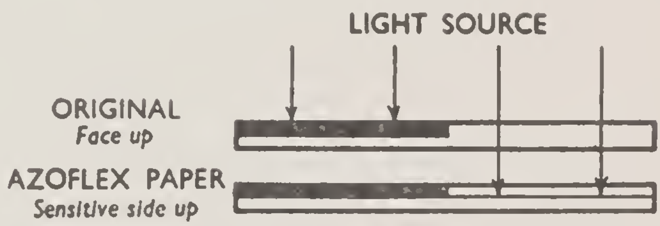


Fig. 15. Making an Azoflex print from a single-sided original.

because of their transparency, economical when low multiple or onger runs are required as they reduce the exposure time to a minimum, thus giving the maximum output to the machine. The whole process is daylight operated and is therefore particulary suitable for office use.

CHAPTER XIII

PHOTOCOPYING APPARATUS USING DIRECT POSITIVE OR DIAZO PAPER

APPARATUS WHICH is designed to use existing sensitive materials has been introduced into the photocopying range. Some of this is able to meet the requirements of smaller users and is particularly useful for occasional copies, but other machines are economical when the number required does not justify the continuous type of apparatus. These smaller machines are generally designed to use the direct positive type of material throughout, but some can make a master on this paper and produce the final copies on diazo paper.

The following are some of the important machines in this range.

Remflex. This is a printing machine of the non-rotary type which is able to produce copies up to 13 × 16 in. It employs the direct positive type of paper which can be printed direct when single-sided copies are used or by the reflex principle with opaque or double-sided copies. The final print is always on the direct positive type of paper.

The light source is sufficiently powerful to enable short exposures to be given and the vacuum pressure lid is able to give good contact even with books of reasonable thickness. This lid is counter-sprung to open automatically at an angle of about 60 degrees.

The processing unit is of the semi-dry porous-block type and is mounted at an angle of 15 degrees, making it convenient for the operator to handle the copies. This may be replaced by the automatic processing unit, if required.

Dyflex. The Dyflex apparatus differs from the Remflex by incorporating two light sources of different values. One light source which is similar to that in the Remflex equipment is designed to produce direct positive copies or intermediates from any original on direct positive type of paper. The other light source is a low-wavelength blue light which is used for printing this intermediate master on diazo paper. It will be seen that this machine is intended for low-multiple

copies, the cheaper diazo paper making it more economical than the Remflex when more than two copies are required.

The processing unit is similar to that of the Remflex but incorporates in addition a small developing machine for the diazo material. This is able to develop both sides of the paper simultaneously when double-sided copies are being made, and to produce prints up to 13 × 16 in. When a greater output of work is required an automatic processing machine is available for making the direct positive masters. This will develop and stabilize in one complete operation giving a considerable increase in output over the slower block method.

The Copyline. The Copyline range of machines for these materials include some in which, in addition to the exposing unit, rotary processing units are housed for developing both the direct positive and the diazo papers.

The Duostat. This apparatus is of the Reflex type, containing a dual light source which enables both the reflex and the direct positive types of paper to be used. Available in small sizes for office use, and with one machine fitted with a vacuum blanket to enable books of varying thickness to be copied, the range also includes a model able to make copies up to 40 × 30 in., intended for use in the drawing office. The processing equipment supplied with Duostat apparatus is of the porous-block type. When copies are expected to be kept over long periods and must be wet-processed, trays are available for this purpose.

The Contura. This is a small portable box available in various models which are able to produce copies on either Reflex or direct positive paper according to the model used. This apparatus differs from all other types by having a translucent inflatable cover through which the exposing light is made to pass. In use this cover together with the sensitive material is pressed into contact with the original; the softly inflated cover being able to follow the contour of a thick book and thereby enabling it to make contact over the uneven surface.

Exposure is made by the Reflex principle; the lights contained in the lid of the box penetrating the inflated translucent cover to expose the material and produce the master. Copies are made by direct printing with the same apparatus. Both the wet and semi-dry methods of processing are available and also a small unit for processing material of the transfer type.

The Burostat. This apparatus consists of two units, one for making

the exposure and the other for processing the copy. The exposing unit has a curved glass top fitted with a pressure band and is able to copy books of reasonable thickness. A unique feature of this apparatus is the voltage compensator control unit which indicates any voltage change, allowing it to be corrected, thus ensuring that correct exposure is maintained. Where voltage fluctuations are frequent and inexperienced staff are employed this small addition can do much to produce an even quality of result.

The processing unit is contained in a shallow box. The block is made of special blotting-paper which is intended to be destroyed when no longer usable. It is said that this block can process many hundreds of prints before it is necessary to discard it.

The Replicta. This is a small portable unit of extremely simple design. The tubular lamp-light source is housed in a cylinder over which a blanket may be stretched to give contact between the original and the sensitive paper.

The unit is intended for making intermediate masters by the direct positive type of paper from opaque originals and printing these or other translucent originals by dry diazo paper. A small ammonia developing unit is available which will develop these prints and also special non-spill tanks or dishes for processing the direct positive paper. These are fitted with a sponge rubber material which contains the required chemical. The exposed paper is laid face down on this and pressed into contact by the lid of the dish for development. It is then transferred to a similar dish for stabilizing.

Other apparatus, much of it of foreign manufacture, is also available in a wide range. Generally this kind of apparatus is of the small non-rotary type and is therefore particularly suitable for the small reproduction section or office where requirements do not justify the more elaborate rotary equipment.

CHAPTER XIV

SMALL CONTINUOUS DIAZO MACHINES

THE INCREASING USE of diazo paper in document reproduction, particularly in connection with the translucent master, has encouraged the development of small rotary machines able to produce copies at reasonably high speeds.

This apparatus has been specially designed for use in the office, being self-contained with both exposing and developing units. Not all the machines are true combines, in which the paper is passed automatically from one operation to the other, but generally they are of the semi-combine type where the print emerging from the exposing unit is manually guided into the developing rollers for continuous development.

The maximum width of paper accommodated on this type of apparatus is normally up to about 16 in., but some machines are able to take paper slightly in excess of this width.

The usefulness of these machines has been extended by their ability to produce, in addition to diazo prints, masters on the direct positive type of paper. Some of the more versatile machines are able to produce masters and prints by most of the well-known processes, and are therefore useful where special apparatus cannot be solely employed on the production of diazo prints.

To enable high-speed printing to be maintained from a large number of translucent masters, a special automatic machine is available which will select the master, print a preselected number of copies and continue this operation until the masters are exhausted. This machine, the E50, is available in the Azoflex Océ range, and is obtainable in three models, able to print 8×10 in., 8×13 in. or $8\frac{1}{4} \times 11\frac{5}{8}$ in. respectively. The diazo paper is used in roll form, which after exposure is cut to the correct size and developed. Preselected controls are available which permit the required number of copies to be printed, after which the machine will eject the finished master and take a new one to repeat print the number selected. Having a maximum production rate of 1,500 copies per hour, the machine

can do much to provide prints at high speed and with the minimum of staff requirements.

The Systematic, which belongs to the Copyline range, has been designed to bring copying into the systems field. It also uses diazo paper in rolls up to 10 in. wide and is designed to work from translucent masters, allowing these to be held in the printing-head until the required number of copies are produced. The operator can preselect the number of copies required by moving a pointer round a numbered dial. After exposure the paper is moved through the machine to a predetermined distance, which can be variable from 6 to 14 in. It is then guillotined to correct size and automatically developed. Since all these operations are automatic, it is able to produce about 1,000 copies per hour.

The Systematic can be used with masters either in single sheet or continuous form. It can also be used with a basic form which travels across the machine with each exposure, allowing variable information to be printed. This would eliminate the necessity to preprint the paper.

In producing an increased number of photocopies with the minimum of labour costs, all these small continuous diazo machines have done much to widen the scope and lower the cost of office document copying. They have provided a means of producing quickly and cheaply a few copies each from a large number of prepared masters. They thus enable photocopying to fulfil a useful purpose and meet a need not served by any of the other processes.

Where translucent masters are used in quantities or photocopying masters are being frequently printed, the use of continuous machines, with their higher speed, will always produce copies with the greatest economy and their use should therefore be given careful consideration.

CHAPTER XV

THE DIFFUSION TRANSFER PROCESS

THIS PROCESS is a rapid and simple method of making copies from practically any type of original. It is based on a method of reversal transfer by diffusion, and for this reason is generally referred to as the Diffusion Transfer method. The process, which belongs to the silver halide group, should not be confused with other transfer methods which use dye or carbon as the chemical agent transferred. These methods are discussed under 'Verifax' and 'Azoflex(Océ)'.

The Diffusion Transfer process was originally introduced on the Continent, by Agfa of Germany and Gevaert of Belgium. Numerous manufacturers have been allowed to produce apparatus for use with this material, supplied by these two firms. This has created considerable confusion, because it is not generally recognized by those unfamiliar with the process that the same principle is being applied and the same materials are being used in a wide variety of apparatus, each of which is classed and styled as an individual process. The position may be clarified by remembering that, with the exception of the two processes mentioned above, any apparatus which produces a positive copy by direct transfer from negative material belongs to the diffusion transfer group, irrespective of the name applied to that apparatus.

To make a copy by this method, a sheet of negative paper is exposed in contact with the original. The negative sheet is then passed through a single solution developer, together with a positive transfer sheet. Emerging from the machine, these two dampened sheets, negative and positive, are brought into contact by roller pressure and after being left in contact for about 30 sec., they are peeled apart, giving a negative and a positive copy of the original. Some positive papers are capable of producing two or more copies by repeating this procedure, thus providing a greater economy to the process. The negative cannot be used again after it has produced the copy or copies, and is therefore generally discarded. However, if it is fixed in hypo, washed and dried, it can be used to provide contact prints by the normal reflex process previously

described. Where a number of copies are required it is possible to use a positive translucent paper or film, the transferred image providing an excellent printing master for making prints by the diazo method, or it can be used to make a plate for offset lithography.

The principle used in diffusion transfer is interesting and unusual. The negative sheet contains light-sensitive silver salts which are converted to metallic silver by exposure and development. This will produee, as in all similar photographic processes, a negative in which the black areas of the original appear with reversed reading, as white on the negative. The positive paper is not light sensitive but is chemically treated and contains hypo, which is dissolved during the passage of the sheet through the developer. When the negative and

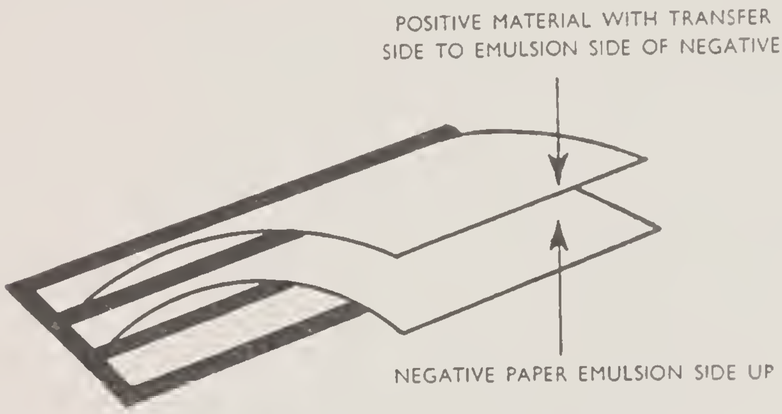


Fig. 16. Development of a single-sided copy.

positive papers have been squeegeed together at the end of the processing operations, the hypo dissolves out the unused silver salts from the negative and enables them to be diffused into the positive paper. The silver salts, with the help of substances incorporated in the positive layer, are reduced to form a positive image, having black writing on a white ground.

Positive prints produced by this method will remain in good condition over long periods. The stability of the transfer print will depend to a large extent on the manner in which it is stored. Warm, humid conditions are very harmful and prints which have to be stored under these eonditions, or are proeessed in tropical climates, should be washed to preserve them. Owing to their alkalinity, the fixing salts are quickly removed by washing in running water for about ten minutes. The stability of the washed print eorresponds to that of a correctly washed photographic print. Where prints are required for archival purposes their keeping qualities can further be improved by rinsing them in a 1 per eent solution of potash alum for 1 min. and then washing them for a few minutes in running water.

The developing solution used in this method is of a weak, caustic alkaline type, which has a tendency to absorb carbon dioxide and oxygen from the air and therefore to lose activity. When prints are made with a weak, alkaline developer they show a slight yellowing of the background, a fault common with the earlier results of this process. The yellowing colour has no effect on the permanence and legibility of the prints, but tends to destroy the clean appearance of the copies. It can be removed by a brief immersion in a 2 per cent acetic acid solution, followed by a thorough wash in water. To overcome this staining tendency, manufacturers are now marketing developing solutions which contain a bleaching agent, and this will produce copies with a clean white background. However, when

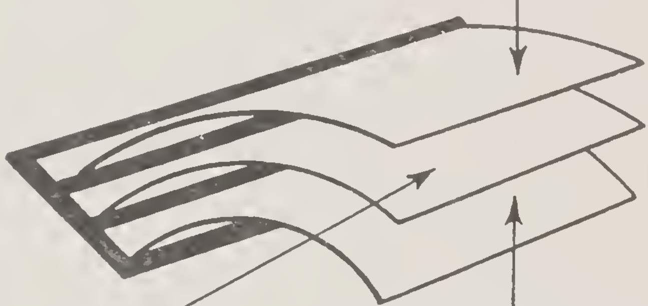


Fig. 17. *Development of a double-sided copy.*

transparent film is used for making intermediate printing masters for diazo it should always be well washed or sponged, for 1 to 2 min. after processing. If this precaution is not taken the film will rapidly discolour in the printing machine, thereby minimizing its effectiveness as a printing master. It may also stick to the hot cylinder of the printing machine, causing much inconvenience and loss of time.

The negative paper used in the transfer method is available in various sensitivities. The slow variety is particularly suitable for office use, but it must not be operated in bright daylight. The more sensitive paper is faster to use but requires more shielding from direct daylight. A negative paper is also available which is extremely sensitive, and this is intended for exposure by projected light. It can be used to prepare prints of a size differing from that of the original, but it must be operated in a room illuminated by a suitable safelight.

Transfer-positive papers are available coated on both sides, for producing double-sided copies. This paper is sandwiched between two exposed negatives and fed into the developing machine. When

these are later stripped from the transfer sheet, it will have a transferred image on each surface.

Papers are also made in various thicknesses, including airmail and card. The airmail paper is laminated to a strong supporting base, to enable it to be handled in the developing machine. After development the paper is peeled from its support.

Apparatus is available commercially in a wide range, including combine machines, which house both the exposing and developing units. Some machines are intended for copying from both single sheets or books. Exposing machines, using ultra-violet light sources, such as the small diazo apparatus, can also be used but the exposure must be carried out behind a yellow or reddish filter.

The copy produced by the diffusion transfer process is of very good quality. The method is not difficult to operate, and as it can produce single or low multiple prints economically, or printing masters for cheaper methods when more prints are required, it is a particularly useful means of document copying.

Paper for the transfer method is now made in this country by both Ilford Limited and Kodak Limited. More recently the usefulness of this method has been extended by the introduction of Multi-copy paper which permits 12 or more copies to be made from each negative. It is about 60 per cent dearer than the normal type but it is economical when three or more copies are required from one original.

A further important development with this method has been the introduction of specially coated metal lithographic plates for use with the small offset machines. The plate is made by using a special negative material which, after being exposed in contact with the original is passed through the developer together with the metal plate in the usual manner. The two materials are separated after a few seconds giving a metal plate bearing a positive image of the original. This is treated with fixing solution and is then ready for the offset machine, the whole operation taking about one minute. The plate will normally produce many thousands of copies and it is estimated to cost about 3s. 6d.

Most of the transfer apparatus already in use is suitable for making these plates but in general it has been found that the very fast rotary types are not as satisfactory as the slower rotary models or the flat bed book types which are particularly suitable. Some firms are introducing special flat bed apparatus together with a rotary developer for use with the lithographic process.

Both Gevaert Limited and Kodak Limited supply these plates. They are extremely simple to use but care must be taken to align the image when the plate is being transferred from the negative.

CHAPTER XVI

VERIFAX

THE VERIFAX PROCESS, which may also be considered as a transfer method, produces an intermediate negative, called a matrix, from which normally up to six copies may be produced on ordinary, unsensitized paper. The number of copies obtainable is determined by a number of factors and, under favourable conditions, up to ten or more may be made, but each succeeding copy will grow weaker until they are no longer acceptable. The Verifax master consists of a fairly stiff sheet of paper coated with a gelatine emulsion, containing a light-sensitive silver compound, a tanning developer and a dye-forming component. It is exposed in contact with the original by the reflex method, which allows light to penetrate the paper base and finally reach the emulsion. Development is made in an alkaline solution and has a tanning effect on the exposed areas. During development the parts which have received the greatest exposure are hardened, and in this condition will adhere to the matrix. The unexposed areas are then dyed and partially developed. The master is then brought into contact with the copy paper and a layer of unhardened dye material is transferred to it. By rapidly repeating this operation of developing the matrix and bringing the copy paper into contact with it, the lower layers of unhardened matrix materials are successively transferred to the copy sheet, giving a positive copy.

The master is usable for a very short period only; all the required copies have therefore to be made with a minimum of delay, and for this reason the master cannot be stored or re-used at a later period.

The matrix image can also be transferred to paper lithographic plates, thereby creating a printing master for the offset process which is able to give runs well in excess of normal duplicating requirements.

The apparatus used with the Verifax process is small and compact and therefore especially suitable for office use. Although compressed in size, it is completely self-contained. The exposing unit, which consists of numerous small bulbs, is situated at the top of the copier and the developing solution is contained in a tray within the lower part. Automatic timers are incorporated and controlled

heating elements keep the activator at the correct temperature, making the process as simple as possible.

The model generally available in this country is able to take prints up to $8\frac{1}{2} \times 14$ in. Other models are available, one of which is extremely small, with the light source fitted above the apparatus, and there is another one which can only make prints up to $8\frac{1}{2} \times 11$ in.

The Verifax process must not be operated in strong daylight but can be worked in normal room lighting. The matrix paper is coated on one side with a visible coating and a 2 in. uncoated portion at the end of the sheet which allows it to be handled without making contact with the liquid used in the machine.

Normally described as a soft gelatine transfer process, Verifax, although classed as a transfer method, must not be confused with the diffusion transfer process. In the first process the image is dye transferred to uncoated paper, but the diffusion method requires two specially prepared papers, each coated with a gelatine emulsion, one of which is light-sensitive. The transference of the image in this latter method is made chemically.

The first few copies produced by the Verifax process are of good quality and some of the succeeding ones are usually quite acceptable. The greatest economy given by this method is when three or more copies are required from the same matrix, as will be seen by the following charts supplied by the manufacturers.

COST INDEX FROM 1 TO 6 'VERIFAX' COPIES

PRICES INCLUDE ALL MATERIALS

Rates based on using Matrix Paper $8\frac{1}{2} \times 11$ in. in packets of 500 Sheets

NUMBER OF COPIES	1	2	3	4	5	6
Total Cost ..	7·48d.	8·06d.	8·64d.	9·22d.	9·80d.	10·38d.
Cost per Copy ..	7·48d.	4·03d.	2·88d.	2·30d.	1·96d.	1·73d.

Rates based on using Matrix Paper $8\frac{1}{2} \times 11$ in. in packets of 100 Sheets

NUMBER OF COPIES	1	2	3	4	5	6
Total Cost ..	8·20d.	8·78d.	9·36d.	9·94d.	10·52d.	11·10d.
Cost per Copy ..	8·20d.	4·39d.	3·12d.	2·48d.	2·10d.	1·85d.

Rates based on using Matrix Paper $8\frac{1}{2} \times 14$ in. in packets of 500 Sheets

NUMBER OF COPIES	1	2	3	4	5	6
Total Cost ..	9·32d.	10·04d.	10·76d.	11·48d.	12·20d.	12·92d.
Cost per Copy ..	9·32d.	5·02d.	3·58d.	2·87d.	2·44d.	2·15d.

Rates based on using Matrix Paper $8\frac{1}{2} \times 14$ in. in packets of 100 Sheets

NUMBER OF COPIES	1	2	3	4	5	6
Total Cost ..	10·26d.	10·98d.	11·70d.	12·42d.	13·14d.	13·86d.
Cost per Copy ..	10·26d.	5·49d.	3·90d.	3·10d.	2·63d.	2·31d.

In addition to the standard Verifax machine two others have recently been introduced at very competitive prices.

The Signet is able to take copies up to $14 \times 8\frac{1}{2}$ in. and although it is not as elaborate as the standard model it has proved to be very satisfactory and, because of its price, popular. With this model the exposing light is above the processing unit but in other respects the principle is the same.

The Bantam, which is the lowest price of the three models is able to copy up to $11 \times 8\frac{1}{2}$ in. It is of an entirely new design, very compact and simple to use.

CHAPTER XVII

THERMOFAX

THERMOFAX is a single-step, dry method of producing copies. There are no finishing operations, intermediate masters, translucencies or chemicals needed, and the entire copying operation is completed in about 4 sec. The material used in this process is a thin, heat-sensitive paper which is not sensitive to normal light and can therefore be operated in any room. It is generally available in various colours or tints, the most popular being buff. A white-base paper is also available.

To produce a copy, this paper is placed in contact with the original to be copied and exposed to infra-red light within the apparatus. The white parts of the original reflect most of the heat but the black parts absorb and re-radiate the heat, which penetrates through to the heat-sensitive coating of the paper and so produces a positive copy. Copies can be produced from virtually any type of original, opaque, translucent or transparent, printed on one or both sides. It will also produce passable copies from a half-tone print, but it is necessary in all these cases for the original image being copied to have a carbon or metallic content, otherwise the heat is not radiated and will not reproduce. Certain inks are therefore quite useless, but faint lines drawn by metallic pencils, or other metallic colours, will reproduce as a black line or tone.

When making copies from originals printed on both sides, the Thermographic paper is placed with the sensitive side up and the non-sensitive side in contact with the original. Light passing through the paper and striking a black area, which may be a letter, figure or drawing, is converted into heat energy, which when transferred to the Thermographic sheet, causes a colour-change reaction. Any characters on the reverse side of the original do not copy, as they absorb too little heat light to be effective.

The number of copies which can be produced by this method is restricted only by the normal economic limits which must be applied to all document-copying processes. The heat of the machines has no harmful effect on the original document, but the cost of the sensitized

paper is a restriction in the number which can be produced economically. The copies have black lettering and are of reasonably good quality. The image is permanent to light but will be destroyed by heat, because the original exposure does not affect the heat-sensitive coating in its unexposed areas. It is therefore still possible to re-expose these parts, adding additional information if required.

The apparatus used in this process is pleasing in design and intended for office use. It incorporates a filament light source lamp which can be used immediately after switching on. A number of machines are available, the most popular in this country being the 'Secretary', a small, office machine, which is able, by one continuous action, to produce a copy in 4 sec. from single sheets or very thin booklets. The 'Fourteen' is used for brief-sized paper, but the 'Premier', being of the flat-bed type, is suitable for copying books or other thick documents.

The cost of the heat-sensitive paper used in this method is a little higher than of that used in some of the other methods, but the advantage of the process would appear to be its usefulness in the office, where it can produce quickly and without chemicals, fumes or skilled labour, a positive copy from an original, which may be transparent or opaque. The copy so produced cannot normally be used as an intermediate master for diazo printing, because the heat of the diazo machine may discolour the Thermofax paper and render it unsuitable for further use.

CHAPTER XVIII

KALFAX AND SIMILAR METHODS

UNDER SERIOUS DEVELOPMENT in this and other countries, the Kalfax process promises to be a useful addition to the widening field of documentary diazo copying. It is a dry process, using what may be described as vesicular material, and this is exposed by ultra-violet light and developed by heat of a moderate temperature. The sensitivity of the emulsion allows the paper to be handled in ordinary room lighting, but permits exposure to be made in the conventional diazo exposing machines, and some material may be developed by the normal heat generated in this type of apparatus.

The finished print is a positive with black lines on a whitish base. It is claimed to have an image permanency greater than that of silver halide emulsions, comprising as it does a carbon-black line on a white foamed plastic background. The prints produced by these methods are of a higher quality than those made on normal diazo papers, and good continuous tone prints can be made from suitable originals, but, as with all diazo-type copies, contrast is increased somewhat.

The Kalfax paper may be obtained in a variety of colours. In common with other heat-developed methods, additional information may be added to the same sheet by subsequent re-exposure at a later period, because the original development of the material does not destroy the sensitivity of the unexposed areas.

The sensitive emulsion can be coated on all types of material, including glass, wood and punched or record cards. It may also be sprayed on large sheets of metal to prepare templates for photo lofting and similar purposes.

Apparatus for the Kalfax process is available in the U.S.A. for both contact printing and enlarging.

The contact photocopy machines produce copies up to 11 × 17 in. and are said to make copies from opaque originals by the reflex principle. A continuous form of copier is under development, which will continuously expose and develop any length of paper up to 11 in. wide.

The Microfilm enlargers can print from both 16 and 35 mm. film and make prints up to $8\frac{1}{2} \times 14$ in., or, with modifications, 17×22 in. Exposure is of about 30 sec. duration, after which the paper is passed on for development whilst a further frame is exposed, thus producing about two prints per minute.

Printing machines for contact printing both 16 and 35 mm. or 70 mm. microfilm are able to expose and develop in one operation, at speeds of 5 to 24 ft. per minute. The primary purpose of this apparatus is for reproducing microfilm in roll form.

It is expected that, when available in this country, the price of the vesicular type of material will be somewhat dearer than diazo but cheaper than silver halide paper. The complete elimination of chemical developers and the production of a direct positive copy of good contrast make this an ideal office process, embodying simplicity with photographic quality.

CHAPTER XIX

XEROGRAPHY

Pronounced Zee-rog-ra-fee. From two Greek words, Xeros = dry and Graphein = to write.

XEROGRAPHY is an electrical and mechanical method of image reproduction. The process is dry and there are no chemical solutions or fumes. The photoconductive plate used in this method, which corresponds to the film or plate used in ordinary photography, consists of an electrically conductive backing material, the face of which is coated with selenium. This coating will not conduct electricity in the dark, but becomes conductive when exposed to light.

The plate is electrically charged in a few seconds by a simple device, which is incorporated in the apparatus used, and in this charged condition is sensitive to light. The sensitized plate may be exposed by contact, or projection, or in a camera in the same manner as photographic emulsion. During exposure, light striking the plate makes the coating conductive and discharges the electrostatic surface charge into the metal backing. Where light does not fall on the plate because of the black areas in the original the surface charge remains, thereby creating a latent electrical image. The plate is developed by passing a specially prepared powder over its surface, This is attracted to the charged portions only, resulting in a reversed (mirror reading) positive image of the original.

A copy is made by laying a piece of paper, or other receiving material, over the powdered plate and charging the paper with the same electronic device used to sensitize the plate. The image is then transferred to the paper, producing a positive copy of the original. This image is then made permanent by heating the print, which melts the powdered granules and fuses them to the paper.

The principle of Xerography may be applied to meet requirements other than simple document copying. Perhaps its most important function is in the making of both paper and metal plates for offset lithography. Printing masters for the spirit process and also translucent ones for diazo printing can be made by this method. Xerographic printing is a method of printing many copies from each master, and

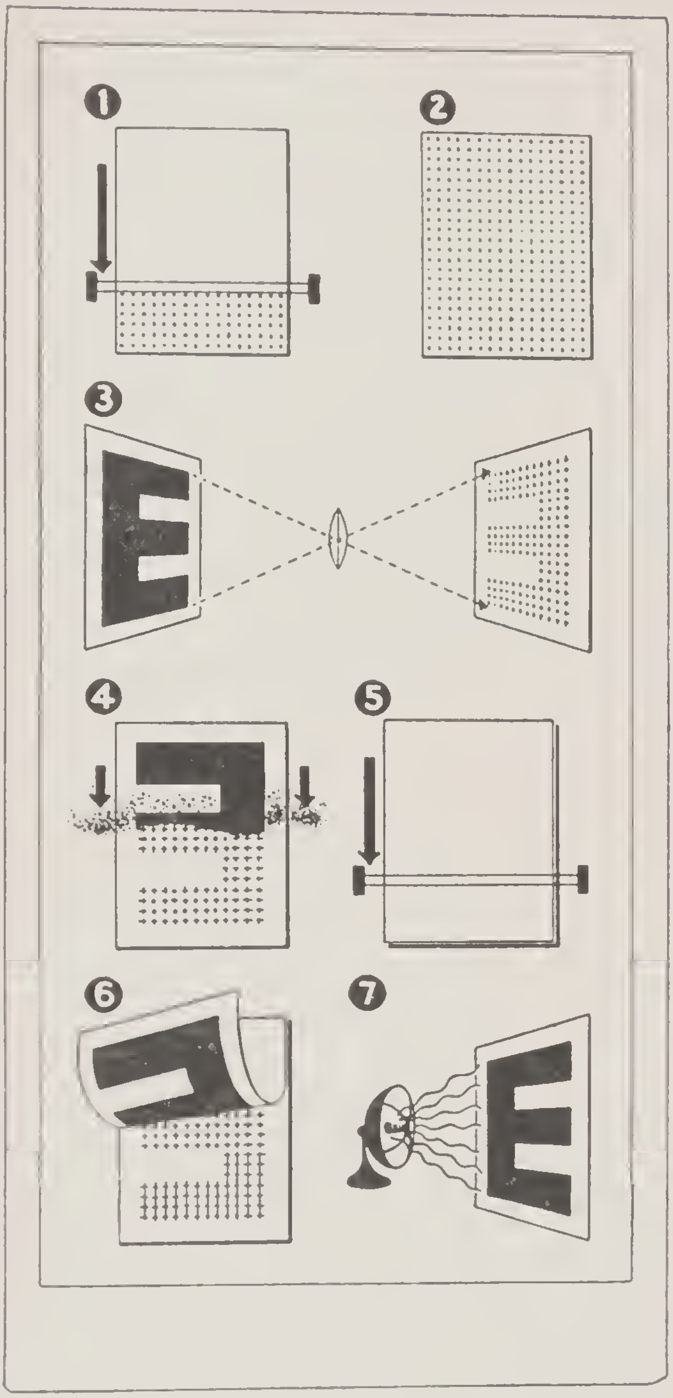


Fig. 18. How Xerography works. 1. *Surface of specially coated plate is being electrically charged as it passes under wires.* 2. *Shows coating of plate charged with positive electricity.* 3. *Copy (E) is projected through lens in camera. Plus marks show projected image with positive charges. Positive charges disappear in areas exposed to light as shown by white space.* 4. *A negatively charged powder adheres to positively charged image.* 5. *After powder treatment* (4) *a sheet of paper is placed over plate and receives positive charge.* 6. *Positively charged paper attracts powder from plate forming direct positive image.* 7. *Print is heated for a few seconds to fuse powder to form permanent print.*

the Copyflo is a special machine using xerography to prepare copies continuously from microfilm, 16 or 35 mm. in roll form, or from opaque originals.

By using developing powders which have been dyed to a desired colour, copies can be produced in colours other than black. It is thus possible to make colour reproductions from a Kodachrome or other colour transparencies by exposing three individual xerographic plates through colour-separation filters and then developing them in

powders of a complementary colour. Powders from the three plates are then superimposed to make the finished three-colour prints.

Recently developments in xerography have been made towards the use of continuous-tone copies, and the results, although having a more restricted tonal range than photographic paper, are extremely pleasing and satisfactory for many purposes.

Xeroradiography is the taking of X-ray pictures, in medicine and industry, by xerography. The process is said to be faster and less expensive than conventional X-ray and the image is not sensitive to radiation.

One of the more recent achievements is the preparation of printed electrical circuits for etching. Standard apparatus is used, together with transfer plates and papers. Metal nameplates, signs, dials and dies for embossing leather may be prepared also for etching by xerography. It is claimed that this is faster and less expensive than by conventional methods.

The basic equipment used in xerography consists of three units, camera, processer and fuser. The camera may be of the fixed-focus type to give same-sized copies, or one of more conventional appearance which may be focused to give half-size or one and a half times the size of the original. Any large camera of the copying or process type can also be adapted by the addition of a plate back, which will hold the Xerox plate-holder, thus saving considerable expense where such valuable equipment is already in use. The processer is able to electrically charge the plate and also to develop it. The normal type of fuser is heat-operated, but one is available in which the image is fixed by a vapour.

The operations necessary to produce a plate and a copy are outlined in the diagram. It will be seen that the plate is first charged to a potential of 6,000 volts, which makes it sensitive to light, and is then exposed within the camera to the original copy. The actual plate is contained within a dark slide, as with conventional photography, using sensitive material in sheet form. After withdrawing the dark-slide shutter, the plate is exposed, resulting in a discharge of the plate where any light reflected from the copy strikes it. This invisible image is then placed within the processer and dry powder is cascaded over it. The powder is attracted only to the charged parts of the plate, producing a positive image. Receiving material, which may be copy paper or offset masters, may then be laid over the plate. A further charge causes the particles of powder to be attracted away from the plate image to the receiving material and this when peeled away becomes a reproduction of the original copy. After fusing by heat or vapour the image is made permanent. The time required to

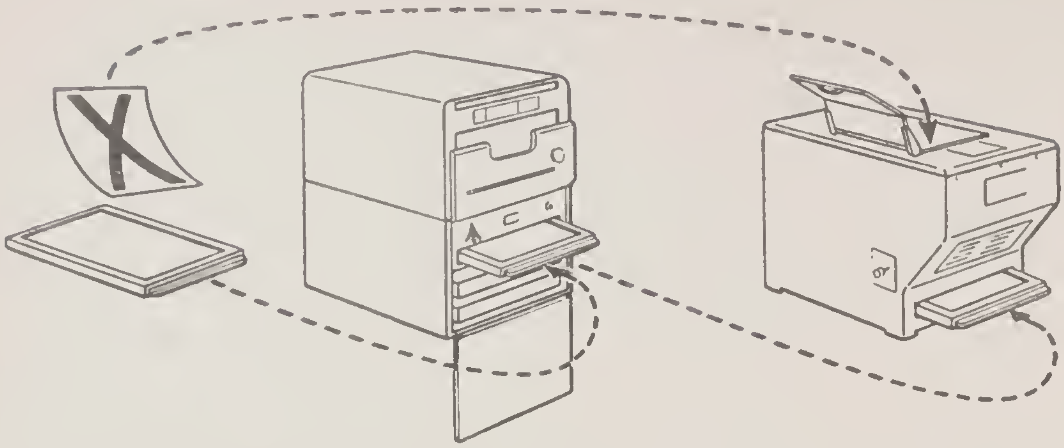


Fig. 19 (a). Xerox plate becomes electrically charged and is exposed to the image of the original copy.

prepare an offset master is about three minutes. This short preparation time, coupled with the low cost of the materials used, make this method of plate-making an extremely cheap one.

The process can produce extremely fine line detail and reasonably good half-tone copies from suitable originals. There can be little doubt that it will make considerable changes in the traditional methods now employed and it may also influence new trends in duplicating and office printing.

Masters for use with spirit duplicators require an additional process. Following exposure, the powdered Xerox plate is transferred to a carbon sheet in apparatus known as the Flo-set unit, after which it is ready for use.

The Copyflo apparatus may be described as automatic xerography because it is able to eliminate the manual operations normally required and to provide copies automatically from roll microfilm or normal opaque originals. In this equipment, the plate is in the form of a hollow drum. All the necessary steps take place simultaneously at various stages on the drum, thus providing a continuous output. As the drum rotates it is successively charged, exposed and developed as powder is cascaded over it. The powder is then transferred to the receiving material, after which the plate is cleaned and the whole cycle is repeated. The copies produced are fused after leaving the drum, and so made permanent. The finished copies are reproduced on a continuous roll of paper, at the rate of 20 ft. per minute.

Three models of this machine will be available, one having a microfilm head, another an opaque head and the third dual heads. The microfilm printer will reproduce for both 16 and 35 mm. film, negative or positive, perforated or unperforated. It can enlarge from

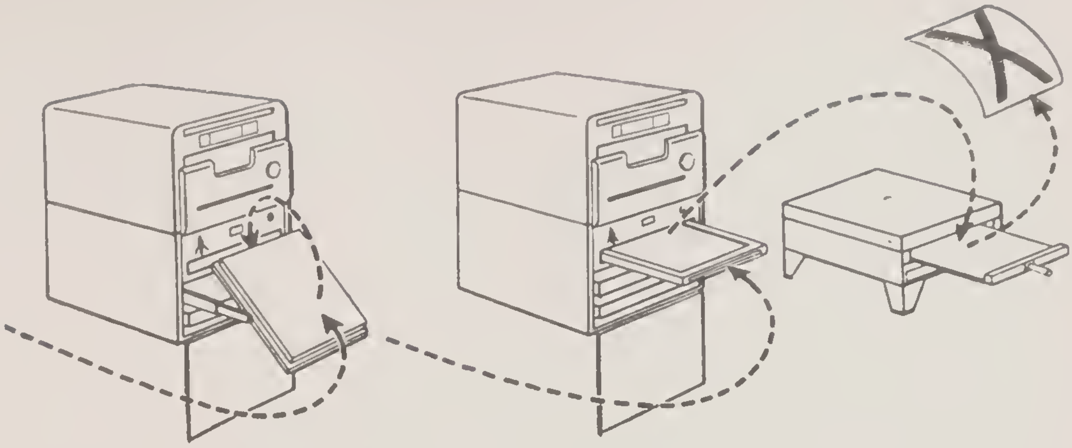


Fig. 19 (b). The electrical image is then developed and the powder image is transferred to paper. The paper is removed and 'baked' or fused to make it permanent.

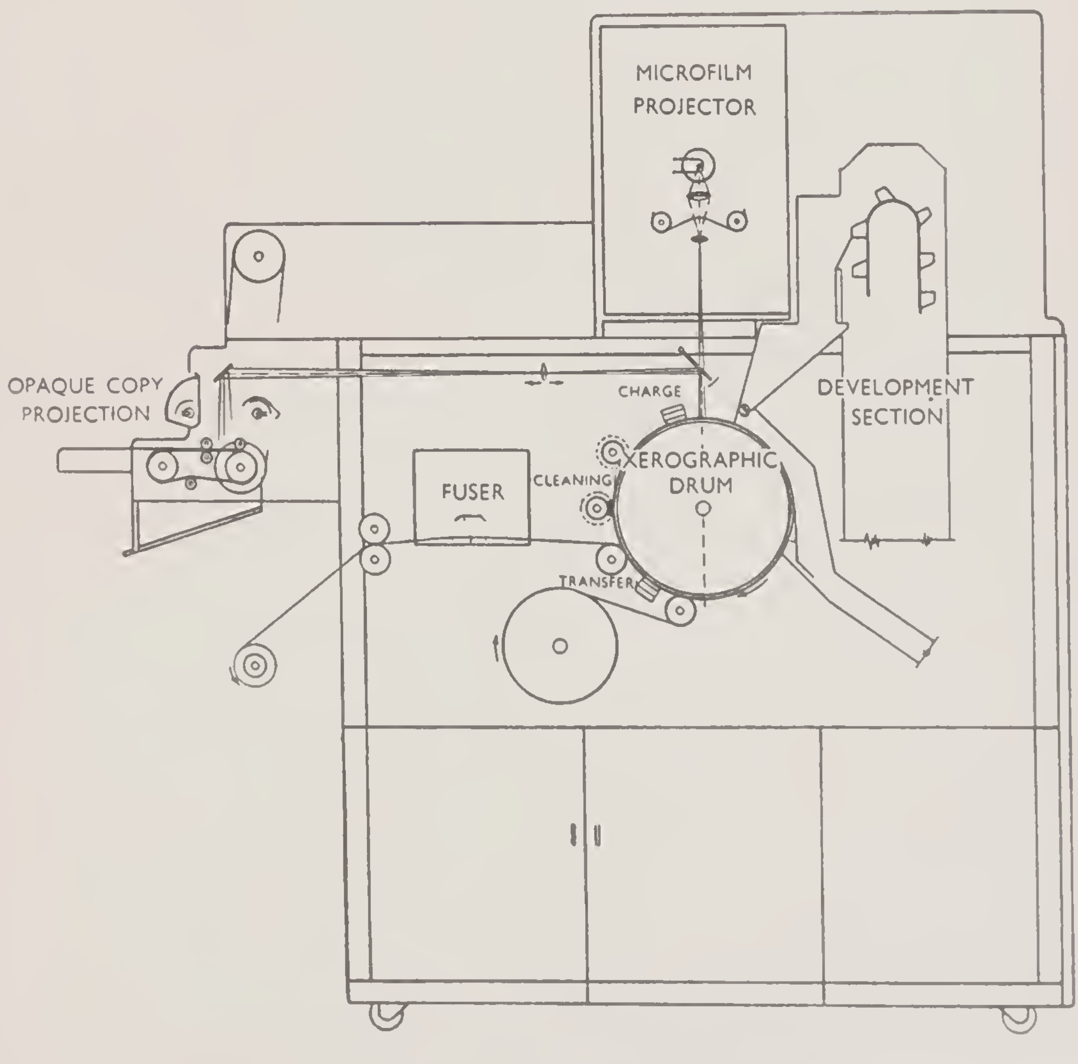


Fig. 20. Automatic line copy xerography.

7 to 24 diameters in fifteen steps, with a finished copy limit of 11 in. width.

The opaque head will reproduce from opaque or translucent originals at ratios from 50 per cent to 200 per cent of the original, the maximum width of the original being 22 in. and the maximum copy width being 11 in. Originals are fed on a belt which passes through the machine, further copies being made by repeating this operation.

The dual head combines all the features of the two previous models and is interchangeable by one control lever.

The cost of this continuous apparatus is very high and could not be justified economically except in centralized sections or very large departments. A service for the supply of copies from microfilm or opaques will, however, be provided by Rank Xerox Ltd.

The Copyflo machine has also been adapted for use as a printer with Electronic Computers. The present output of 3,000 lines of 128 characters will doubtless be exceeded in the near future.

Also available are a number of other rotary machines including the 5B Copyflo. These machines have been designed to enlarge on paper up to 24 in. wide from either 35 mm. films in Filmsort cards, or half plate film. They are intended chiefly for drawing office use to replace the traditional methods. This system is being increasingly used where the number of copies required justifies the installation of the high speed Xerox apparatus.

Recently a much smaller copier known as Xerox 914 has been introduced. This is able to take originals up to 9 × 14 in. but unlike other models it uses cut sheets 10 × 15½ in. and these are friction fed mechanically from a pre-loaded stack. The exposure is photo electrically adjusted so that no skill is required in operation.

The original to be copied is placed face downward on a glass platen and the number of copies required is dialled. The available range is from 1 to 15 copies but the machine can be set for continuous copying. When the printing button is pressed the copies are delivered into a tray at the top of the machine at the rate of one every 10 seconds. As with all xerographic machines the prints are completely dry and permanent. Paper stock of any colour can be used and gum paper can also be fed into the machine.

The 914 model is not available for purchase. The basic rental is £30 per month with a 'Pay as you copy scheme'. Where a hundred or more copies are required each day the cost is just under 4½d. per copy and for 250 copies per day the cost drops to less than 4d. each.

This copier can also be used for making offset plates but the quality will not be equal to that made on the flat bed equipment.

CHAPTER XX

ELECTROFAX

THIS PROCESS, which has been developed by the Radio Corporation of America (R.C.A.), is based on the electrostatic principle and therefore to some extent resembles Xerography. The essential difference between the two processes is that Xerography employs a selenium-coated plate as the photo-sensitive element but Electrofax utilizes an electrically charged paper. The principle can be briefly described as a paper base coated with a thin layer of special zinc oxide in a resin binder. This coated paper is not sensitive to light until the coating is given a negative electrostatic charge. The sensitivity is applied in the dark by passing a charged wire across the coated surface, the charged coating, then being sensitive to light, can be exposed either by contact or by projection, or in a camera.

During exposure the areas which are exposed to light are reduced but the dark, unexposed areas remain unchanged, thus leaving an electrostatic image which can be developed by applying a pigmented resin powder carrying a positive electrostatic charge. This powder is attracted and held by the negatively charged image areas. It is then fixed by melting it so that it fuses on to the paper surface and so produces a permanent image. It will be seen that Electrofax is a completely dry process. The coating is extremely stable, possessing infinite life before and after printing. The image is also permanent. The sensitivity and contrast of Electrofax coatings is about equivalent to a number 4 silver halide paper. It will therefore be seen that the process combines the speed of silver halide paper with the lower cost of some other forms of sensitized material.

The process can be used for a variety of applications, which include the production at high speed of prints from microfilm in roll or other forms. It can also be used for making both lithographic and letterpress plates, and for other graphic arts methods.

The Bizmac microfilm enlarger, which has been designed for use with Electrofax materials, will print from a microfilm in roll form or on cards of the Film-sort type. When using 35 mm. film it operates continuously at speeds up to 30 ft. per minute, giving an output

rate of 15 copies 17 × 22 in. per minute, or 900 enlargements per hour. A particular feature of this apparatus is the incorporation of a photo-electric cell which enables prints of varying lengths, according to the size of the original copy, to be trimmed automatically by a signal from the original microfilm.

The paper is supplied in rolls up to 18 in. diameter and in widths of 5, 8 and 11 in. The apparatus, which is daylight operated, is fitted with automatic focusing and can produce up to 24 multiple copies

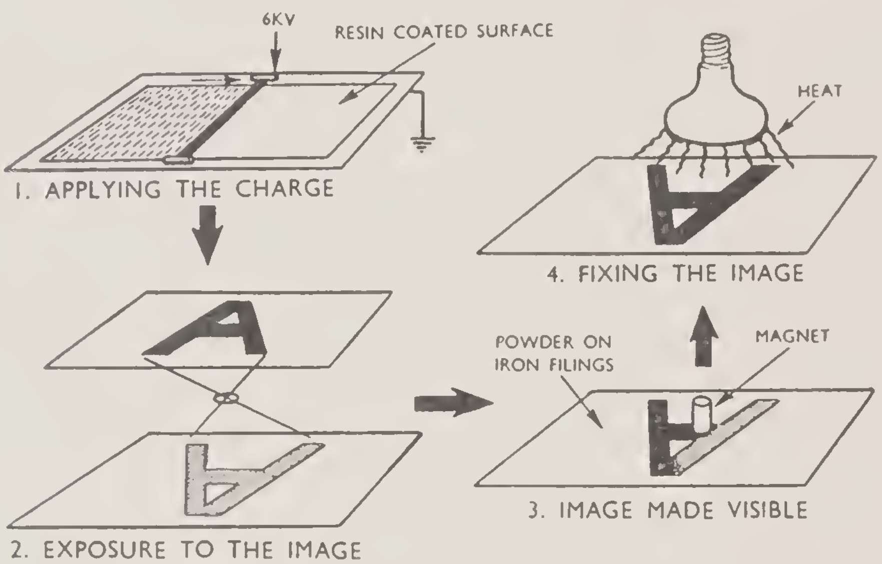


Fig. 21. The Electrofax dry printing process.

from each film. When cards are used they are loaded in a rack above the lens system and automatically dropped into position every four seconds. Figs. 22 and 23 will indicate the principle of this useful apparatus. The inexpensive nature of the Electrofax coating and its suitability for conventional coating techniques, such as whirling, spray, brush or roller coating, opens up many possibilities for its use in graphic arts applications. An advantage given by this process is that these coatings can be stored over long periods without deterioration and they are not light- or radiation-sensitive until electrically charged. Also, images may be deleted or added to and the final image is stable under the usual storage conditions.

Experiments have been made to produce lithographic plates on both paper and metal. Commercial etch and fountains function satisfactorily with these plates and over 1,000 copies can be produced on a paper plate made by this method. A further advantage of this system lies in its ability to produce some tonal gradation without

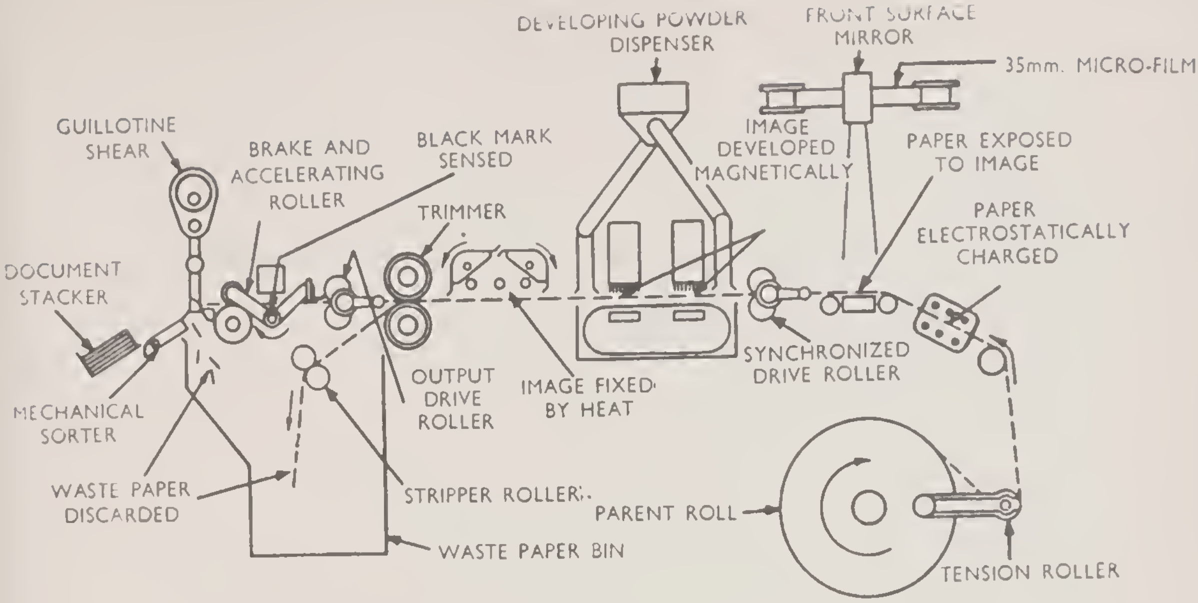


Fig. 22. Schematic of the RCA Bizmac Electrofax printer.

having to screen the image. This is made possible by the magnetic brush system of development, which distributes the powder deposit proportionally to the amount of electrical charge present in each individual area after exposure. However, as the resulting image may be a little contrasty because of the nature of the Electrofax paper, it may be necessary to use rather soft (flat) originals to obtain really satisfactory results. Copies of existing half-tone reproductions may be faithfully recorded because the screen effect is already incorporated in the image.

By a careful selection of the resin used in the Electrofax process it is possible to produce what is effectively a high-speed photo-resist technique. By this means it is said that relief printing plates, dry offset plates, name plates and similar articles may be produced. It has also been found that fused powder images obtained electro-photographically are often raised as much as 0·001 in. or more above the photo-conductive surface. Special techniques enable this relief to be made in a reproducible and uniform manner over the entire image area, furnishing a raised printing surface suitable for dry offset use.

The photo-conductive resin can also be applied to a transparent base to make lantern slides or other translucencies.

It is also stated that electronic type-setting is possible by the R.C.A. Compositron. This enables an electronic arrangement of printers' type at the high speed of 2,000 characters per second. It can take its information from punched paper tape or magnetic tape

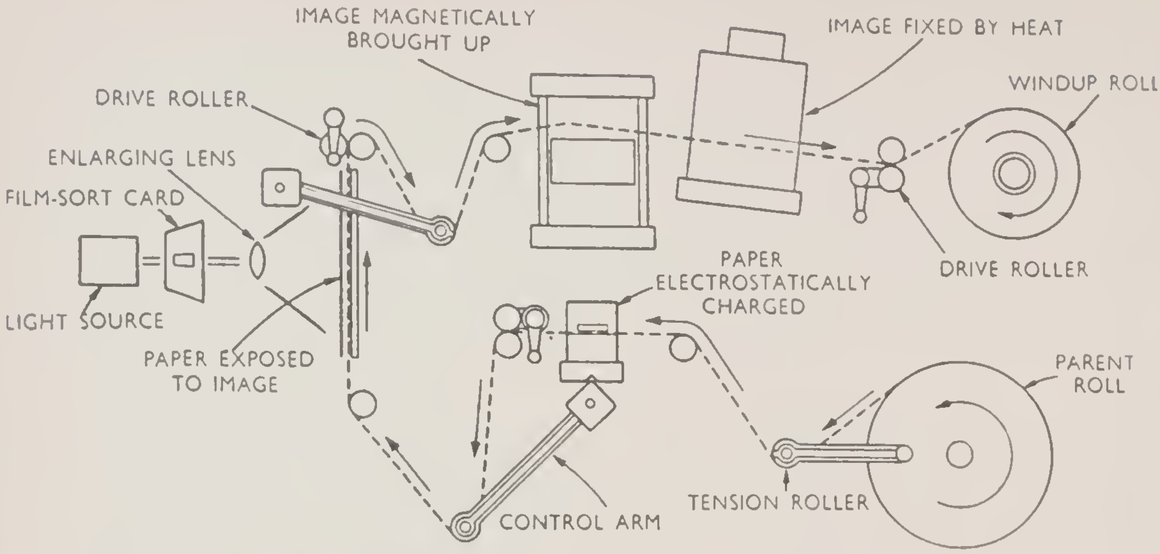


Fig. 23 . Bizmac microfilm enlarger using the RCA Electrofax dry printing process.

and delivers its output in the form of an image suitable for reproduction. The Bizmac electronic printer, using Compositron, will arrange business information in any desired format and deliver its output printed on paper at the continuous rate of 2,000 characters per second.

Electrofax may be regarded as being yet in its experimental stage. Some of its applications have already been developed to meet special requirements and it is expected that other developments will be made to further extend the usefulness of this process.

CHAPTER XXI

PHOTRONIC REPRODUCER

(SMOKE PRINTER)

THIS process has been aptly described as a 'smoke printer' because of the unusual method it employs to produce a copy. Using microfilm, an image is projected from this on to a sheet of glass which is backed with a thin, metallic coating. The paper for the copy is placed behind the glass. The projected image creates a pattern of electric charges on the face of the glass so that vaporized ink, which is first passed through an electrode behind the glass, receives a charge and is attracted to the glass in the pattern of the projected electric image. The electrified ink then settles on the paper, creating a permanent ink copy.

The electrified plate retains no trace of the projected image after the printing cycle is completed. It is therefore able to receive a further projected image and prepare another print immediately. Additional copies can thus be made by changing the paper and

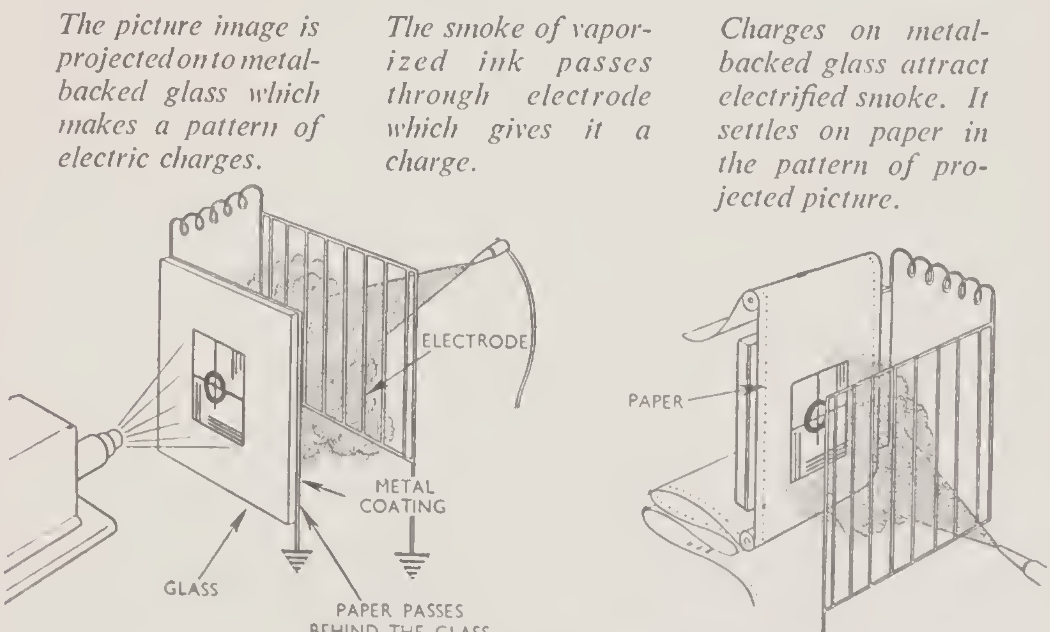


Fig. 24. How to print with smoke.

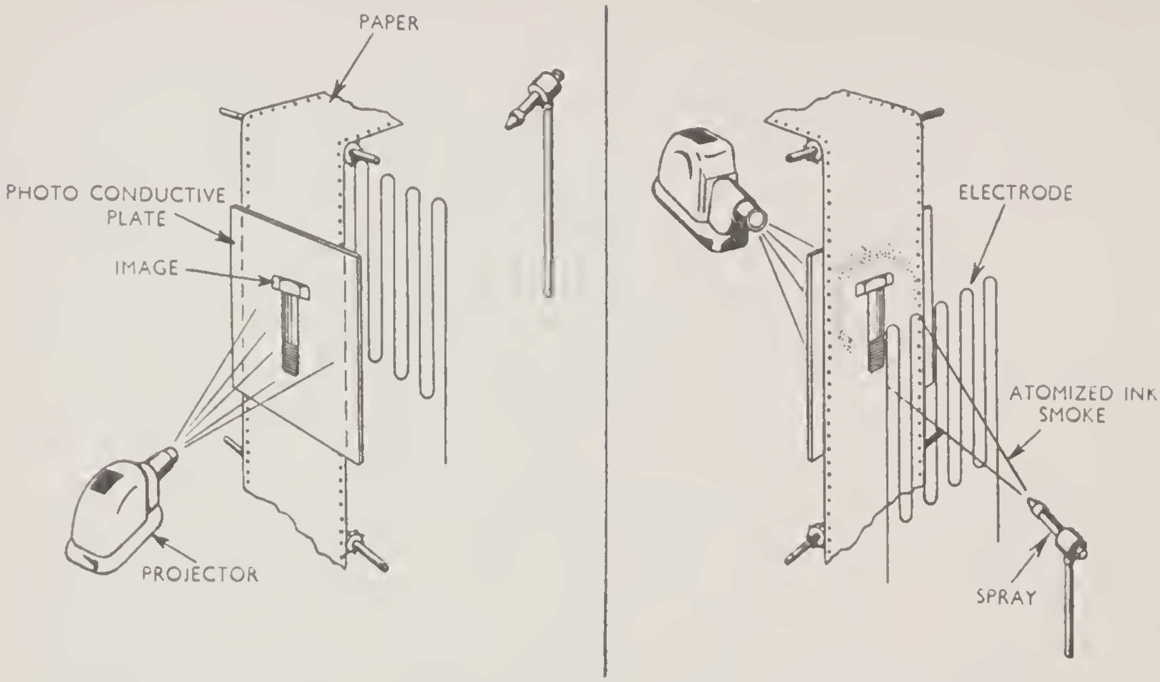


Fig. 25. Principle of the Reproducer. (a) Image of matter to be printed is projected on uncoated or back side of glass plate. (b) Electrostatically charged ink particles are drawn to paper which is in front of the plate, to print the image.

repeating the operation with the same, or another, microfilm image. When the machine is in operation, an automatic cycle-timer alternatively triggers the spray, applies power and advances successive sheets of paper, which are marginally punched to allow this operation to be conducted at high speeds.

The method can also be employed to provide prints from opaque copies. For this purpose a reflex type projector is used, and the same operation is maintained.

A feature of the smoke printer principle is that it allows ink to be transferred to paper without mechanical pressure, as is necessary with conventional printing methods. It is therefore felt that it should be capable, by further development, of printing at speeds comparable with office printing machines.

The experimental apparatus which has been developed for use with this process has been used for printing from engineering drawings and similar documents. It has provided an output speed of 55 ft. per minute, producing $8\frac{1}{2} \times 11$ in. prints at the rate of one print per second. It is considered that production models will provide an even greater output. Also, it is expected that future developments will result in this principle of reproduction being applied in the computor field, recording the output of such machines at extremely high speeds and with good-quality reproduction.

CHAPTER XXII

A BRIEF SURVEY OF MATERIALS FOR DOCUMENT COPYING

SENSITIVE MATERIALS

THE SENSITIVE MATERIALS used with the reproduction processes are generally of high contrast and therefore have a restricted tonal range. Since it is usually desirable to increase the contrast between the print and the base tone of the material used, their purpose is to produce a good black image on a white background. To achieve this purpose special materials have been developed together with special developers which, when employed in conjunction with each other, are able to produce the required contrast.

For those interested in gammas and curves or the more technical aspect of these materials, the data leaflets of the makers are recommended. As a general rule, this type of material requires a reasonably accurate exposure to produce the most satisfactory results. Unlike other emulsions which allow some latitude both in exposure and development, they do not generally give a satisfactory image unless they are fully developed. Development time, however, is normally much shorter than is necessary with ordinary photographic materials, because of the high contrast developers used. With negative material, exposure should be the minimum to give the required background density by correct development, but still leave the lines quite transparent. Over-exposure will degrade these lines, making it necessary to use chemical reduction, otherwise the increased exposure necessary to penetrate the degraded lines will cause some background tone, thus reducing the quality of the print. It should be remembered that exposure controls the density of the negative and development its contrast.

When using sensitive plates which require handling in a safelight, it is desirable to use the light screen recommended by the maker of the material being used and a light bulb of the correct wattage. This is normally only 15 watts, a low power which permits only 'safe' light to be emitted and prevents the safelight getting overheated.

7—DCR

Too frequently lamps of much higher wattage are used, causing damage to the safelight screen and degrading the prints. If the safelight is suspect, the familiar test can be made of placing a penny on a sheet of unexposed material and leaving this near the developing dish for about twice the normal time of development for the material being used. When developed any degrading of the sensitive base will be readily observed, in contrast with the unexposed circle given by the coin.

NEGATIVE MATERIAL

There is an extremely wide choice of photographic plates and films for use in reproduction work. These are normally employed with the process camera and are therefore of a special type, able to create negatives having transparent lines on a dense background. Many of these are known as 'ordinary' and are sensitive only to blue light, and are therefore colour blind. The orthochromatic type is sensitive in some degree to yellow and green, but also very sensitive in the blue region. Panchromatic films are sensitive to all colours but will not reproduce colour, except as a tone. Scientists have classified the visual range of colours and produced a corresponding range of tones, which they consider represent the colours of the spectrum. By the choice of suitable filters this tone range may be readily reproduced, or with the use of complementary filters it may be distorted. This fascinating side of photography is fully explained in all textbooks, or books on Panchromatism, obtainable from the emulsion manufacturers.

A detailed list of the available films for use with reproduction processes is not included in a short review of this nature. Owing to the rapid progress in this field new types are frequently being added. These have improved qualities which enable good negatives to be obtained with the minimum of skill.

PAPER MATERIAL

This material is also available in an extremely wide range. Photographic papers are normally classified as Contact (Chloride or Gaslight), Bromide or Chloro-Bromide.

The contact papers are of a low speed. They are designed to give extreme contrast and to be printed by contact. This material is available in all weights and in different speeds. It is also made on a rough base which accepts colour washes readily and allows copies to be hand coloured.

Bromide papers are useful for making prints by contact or projection printing. They are available in different grades of contrast

and on a variety of bases, including tracing cloth and translucent papers. Chloro-bromide papers, as their name indicates, contain both silver chloride and silver bromide and are generally slower in speed than bromide papers, but can give warm tones by direct development. In all these types, various grades, surfaces and different base tones are available. These variations are readily seen by an examination of the sample booklets provided by all the makers.

The following papers are those which have unusual qualities and are designed for specific purposes.

ACCURACY OF SIZE

Accuracy of size is not often essential for reproduction purposes. Normal papers, particularly those which are fully immersed in chemicals and washed over long periods, could never give scale accuracy. Drying is also important. Prints that are dried by heat through drying machines can be stretched considerably. The distortion given is always according to the direction of the paper travel through the machine, so that two prints passed through in different ways can be distorted either in length or width, causing a wide discrepancy of size when examined together.

Printing paper which is dimensionally stable to a very high degree is available from many manufacturers. This is designed for survey work, cartography, engineering records, profile gauges and wherever dimensional accuracy is required. This dimensional stability has been achieved by the use of base material in which a reinforcing sheet of hard rolled aluminium foil is present as an inter-layer between two sheets of lightweight paper. The layers are bonded together during manufacture and one surface is then sensitized. The appearance of the finished product is similar to that of photographic card, but the metal layer is thin enough to give the foil card a flexibility resembling that of double weight paper.

Copies made on this material will reproduce the dimensions of the original to an accuracy of a few hundredths of 1 per cent, measured in either direction of the print. They will also remain stable under all atmospheric humidity changes.

Another paper of interest to specialist users is waterproof bromide paper. This can be processed at extremely high speeds and is dimensionally stable; also it generally has a surface which will readily accept ink, pencil or crayon. To give it waterproof properties the paper base is coated on both sides with nitrocellulose lacquer. Liquid absorption is therefore confined to the emulsion coating and washing is completed in about 5 min., since neither water nor

chemicals can penetrate the paper base. Drying takes only a few minutes.

The stability of this paper does not equal that of the foil card but is much better than that of normal paper. The general purpose is for high-speed work, where its quick processing facilities are of immense value. It is also used for photo murals, or in the construction of mosaics and other scaled enlargements.

Transfer sensitizing paper is a dry stripping material designed for sensitizing any flat surface, metal, plastic, wood or other substance. The paper is first stuck to the surface in question and the backing is then stripped off leaving a sensitized surface layer which can be photographically exposed and processed. The sensitive layer which is transferred has photographic characteristics, similar to those of an ordinary process plate and can therefore be printed by contact or projection. When used for engineering, the bond with the metal allows any machining operations to be undertaken.

Stripping papers of a translucent type are also available. The emulsion is orthochromatic and of an extremely high contrast. The stripping layer can be stripped from the paper base immediately after washing or when it is dried. This material is useful in photo-mechanical work for making line or coarse screen negatives. It is particularly useful in composite work, since it can be readily cut to size and, being extremely thin, provides a means of laterally reversing the image.

Sensitized translucent paper is also available. This is coated with an extremely high-contrast orthochromatic emulsion on a very strong translucent base. This material is able to give extremely fine detail and good contrast. It is therefore particularly suitable for creating new masters for dyeline and other positive processes.

Also for use in photo-mechanical processes are papers coated with an orthochromatic emulsion. Such papers can be used in the process type of camera and will provide a good-quality negative for subsequent printing down on to an offset plate. Due to the cheaper cost of this material, and its suitability for many purposes, it has been increasingly used instead of the more expensive film or plate material. The surface of this paper readily accepts an opaque retouching medium and can be easily cut to provide composite masters.

DIRECT POSITIVE MATERIALS

The direct positive type material has been fully discussed in the chapter on 'Positive Papers'. This type of emulsion is available coated on various base materials. These include translucent paper,

rag film, tracing cloth and a tri-acetate cellulose base which is highly transparent and of only 8/1,000th in. thick. Light and extra light-weight paper bases are also obtainable. All base materials coated with direct positive emulsion are translucent. The rag film is waterproof on both sides and is largely used for laterally reversed reproduction.

The tracing cloth is also waterproofed and, being durable, is able to withstand hard usage in the printing machine. The possibilities of direct positive paper are practically unlimited, the various base materials making it an ideal medium for reproduction work.

DIAZO PAPERS

The importance of Diazo papers has already been fully discussed, together with the various types and grades available. The sensitive translucent variety designed to create new masters has also been described. The latest addition to the diazo range is the heat-developed vesicular type, which is briefly discussed in the chapter on 'Kalfax'.

DUPLICATING PAPER

Papers for duplicating purposes are available in a wide variety, both of price and quality. No useful purpose could be served here by outlining this extensive list. It is felt that the large duplicating divisions will have experts to buy such paper at a price consistent with quality. Where experts are not available with the necessary experience, it is advisable to use paper supplied by the makers of a machine employed, or a manufacturer of their recommendation. This may be a little more expensive, but it should be remembered that in purchasing for reproduction the basic cost of material is not the only cost. It is therefore frequently found with paper, ink and other materials which are used in these methods that cheap materials may well prove eventually to be very expensive, if they lead to loss of time on the duplicating machine. It is important also to remember that, even with duplicating, good quality is desirable if the work is to be attractive and acceptable.

CHAPTER XXIII

COLOUR RESPONSE IN DOCUMENT COPYING PROCESSES

THE VISIBLE SPECTRUM, ranging from violet to red, has been classified by scientists and a monochrome scale has been selected which corresponds to the relative sensitivity of all colours to the eye. In the more complex forms of photography, specially prepared negative materials and selected colour filters can render the spectrum in accordance with this classification, or can modify and reverse the tonal rendering as required.

In the more simple forms of photocopying, such distinctions between colour are seldom required. The primary purpose of the document-copying methods is to produce all colour in the original as black on a white paper thus providing a copy of extreme contrast and of good readability. The most suitable process for document copying would be one which was completely colour blind to the line colour on the original, but able to destroy any tones which may be present on the paper base. Since this requirement is almost impossible to achieve, it is inevitable that all these processes are colour sensitive and will therefore reproduce as pale grey, and lacking in contrast, the lines to which the process is most actinically sensitive.

Colour response in document copying will differ according to the process being used and, to some degree, in relation to the density of the colour being copied. The result is not always predictable. It has been indicated by tests made over a wide variety of originals that certain colours, particularly those produced by some dyes, are not entirely opaque and therefore tend to give entirely different results from the more opaque colours which were of the same visual density. For this reason extreme caution must be used when assessing the suitability of originals for copying by a given process.

However, it is safe to assume that certain colours will fail to reproduce adequately, whatever the nature of their opacity. As a general guide, it may be stated that colours in the original copy which are similar to the colour of the exposing light used in the machine will not reproduce adequately unless a filter can be used, since this

light will be the one to which the material is most sensitive and will therefore tend to destroy the density of that colour and reproduce it inadequately.

Where a number of different processes are being employed it should be possible to make a satisfactory copy from most originals by using a process which is able to reproduce the desired colour. When originals contain a number of different colours, some difficulty will be experienced in obtaining the correct contrast from each colour.

As a general guide the following chart may be used to indicate the colour response of the various document copying processes.

Process	*Colours which reproduce as a grey line or are lacking in density*
Reflex (Silver Halide) ..	Yellow, yellow-green and green
Photostat without a filter ..	Yellow, yellow-green, blue-green
Photostat with filter ..	Orange and blue-green
Direct Positive	Yellow, yellow-green and green
Diazo	Blue, blue-green and violet
Azoflex:	
(1) Reflex Foil	Blue, green and violet
(2) Transfer	Blue and faint pencil lines
Diffusion Transfer	Yellow, yellow-green and green
Verifax	Yellow, yellow-green, orange
Thermofax	Will reproduce all colours if they have a metal or carbon content
Xerography	Will reproduce all colours but light blue requires a yellow filter.

PART THREE

CHAPTER XXIV

REPRODUCTION BY DUPLICATING MACHINES

IN A BROAD SENSE, the terms printing, duplicating and reproduction mean much the same thing. In practice, however, an important distinction is intended. The term printing is commonly applied to work done by the large machines used in the printing industry. These processes are letterpress, gravure and lithography, either direct or offset.

Applied in its narrow sense, duplicating refers to the work done on smaller machines which are normally designed to product multiple copies from a typewritten master. These processes are hectography (spirit), stencil and offset lithography. Owing to its usefulness over a wide range of applications, the small offset machines are now being extensively used in professional printing houses and special machines have been developed to meet the growing requirements in this field. The line of demarcation between the two worlds of printing and duplicating may sometimes not be clearly discernible to those unfamiliar with all the apparatus used. It may, however, be assumed that apparatus which, by union agreement, can be operated by semi-skilled labour can be classed as an office machine, and its inclusion in the reproduction processes is therefore appropriate.

Small machines, using relief type and therefore giving letterpress printing, are also used for some types of work with reproduction methods. This apparatus cannot be compared in size or speed with the letterpress printing machines used by professional printers, but it is able to produce the same high-quality results.

Processes which (for want of a better name) are described as damp-paper methods are also included here. These machines have been designed for specialized work, but this may also be classed as reproduction.

The principle of each process and a survey of its usefulness are outlined in the following chapters; this information together with the charts contained in the Appendices, will indicate the number of

copies each method is able to produce economically and, where possible, its relative costs. The following considerations, which are common to all the processes, are outlined here to avoid repetition in the individual description of each method.

STORING AND RE-RUNNING

The masters used in the duplicating processes can be stored and re-used when required. A survey of the available apparatus for storing the master for each process is given in a later chapter.

The spirit process is limited in the number of re-runs it is possible to make from each master by the density of the dye deposited on the master. When this dye deposit is exhausted, further copies cannot be made.

Stencils can be re-used until they are no longer serviceable. Their life is determined by the quality of the stencil, the method and the extent to which it has been cut, and the way in which it is handled on the machine. Stencils on which numerous lines have been made by stylo pens are liable to break at the weakened parts, and misuse on the machine may readily destroy them.

Paper and plastic plates used in the lithographic process are occasionally found to be unsuitable for re-use. Much depends on the quality of the plate and the amount of fluid used in the machines, too much of which may soften the fibres of the plate and cause it to buckle.

Metal plates, although more difficult to store, have a long life and can be re-run many times. In some cases when the number of re-runs is uncertain, it may be advantageous to type a diapositive stencil and produce the plate by photolithography. This enables the plate to be destroyed, retaining only the stencil, which can readily produce a further plate if required and also be corrected if necessary. The xerographic process could also be used economically for the same purpose if a copy of the previous run is preserved for use in the Xerox camera.

The relief or letterpress master is able to give an unlimited number of runs, but has the disadvantage that the prepared type face must be kept set up on the cylinders or other masters. This requires considerable storage space and is expensive, owing to the high cost of the type and the cylinder used.

PREPRINTED MASTERS

Considerable economy can frequently be made by using preprinted masters, which are available for all the duplicating processes. These

masters are normally printed (spirit or offset) or precut (stencil) by the manufacturers with the static or non-variable information. The master is finally completed by the typist who adds the variable data. When placed on the duplicating machine both the preprinted or precut information, together with the typed matter, will reproduce simultaneously. Forms and similar documents, containing both static and variable information, when prepared in this way more than offset their cost by reducing the typing time which would otherwise be necessary for their preparation. An additional advantage of this method is that the registration difficulties are avoided and complicated forms or documents can be reproduced without difficulty. It is, however, important to remember that the cost of setting the type to prepare the preprinted masters is not justified unless a minimum of at least twenty-five, having the same format, is required. For the offset process, special ink is available which enables paper plates to be preprinted within the reproduction department, if required.

Where registration is necessary in one direction only, the use of preprinted paper can be economical for the same reason. If registration is required in two directions, some difficulty may be experienced with preprinted paper, and for this reason the preprinted or precut master is preferable.

An advantage in the use of both the preprinted paper and the preprinted master is that the general appearance of the final copy is improved, owing to the printer's type used in their preparation.

COLLATING

A disadvantage of all the duplicating processes and small printing machines is that they produce a large number of copies on single sheets, which require assembling in their correct order. Larger printing machines are able to print many pages on one sheet, these being folded by special machines and brought together by large collating apparatus. The collating problem is therefore considerably reduced. Methods of collating, including small machines suitable for use with duplicating processes, are discussed later in this book.

THE QUALITY OF THE DUPLICATED COPY

It has been said that a copy should only be adequate for the purpose for which it is intended. Much duplicating work falls into this category, since economy and convenience are two of the major considerations. However, these factors should not be used as

excuses for work of poor quality, and some standard of performance should always be expected and demanded. Within the duplicating range are methods which, if operated with skill, can provide copies of an extremely high standard on good-quality paper. Used with the special typewriters now available for this work the results are, to the lay mind, almost undiscernible from that of professional printing. It is for this reason that the long-accepted belief that duplicating machines are incapable of producing quality results should be revised and a truer assessment made of the capabilities of these processes.

When the standards which are obtainable by good typing and duplicating are correctly understood, it will be found that these can be easily maintained by correct supervision and with no additional costs. It is only necessary to recognize that good duplicating is always a credit to the section responsible, and that poor work provides a visual record of slipshod, unsupervised methods which are a permanent condemnation on the department concerned.

CHAPTER XXV

DAMP PAPER PROCESSES

ONE OF THE oldest methods of making copies made use of the familiar screw copying press and a hectographic ink, diluted with water. By this method, damp paper was brought into contact with the original letter and up to four copies could be produced.

Machines employing the same principle, but now considerably modernized and of rotary type, are still in use and are particularly suitable with certain techniques of the telecommunication type.

The master used in this process is prepared by typewriter, teleprinter or a similar machine, using a special copying ribbon of the hectographic type. This master is then passed through a machine to produce the copy, which is on translucent paper and has a blue image which appears reversed if read directly but is clearly visible as a positive copy if looked at through the translucent paper.

Two types of these copiers are available, differing considerably in the methods they use to produce the paper copy. Both methods employ translucent paper in roll form, one having a dry paper which is later passed through a water bath, squeegeed and then brought into contact with the master to produce the copy. The other system uses a glycerine-moistened paper roll which enables it to produce a copy by direct contact with the master.

The paper used in the water-bath machine, although completely immersed in water at one stage, is squeegeed to a moist condition before leaving the machine, after which it rapidly dries, gaining in both line strength and paper opacity in the drying operation. This machine is fitted with a variable-speed control, to enable it to be slowed down to obtain a greater density of line when long runs are required. By this means, and by using a special ribbon, it is able to produce up to thirty copies.

A particularly useful feature of this method is that original documents such as letterheads and invoices can be printed with a hectographic ink, and then used in the typewriter as a preprinted master. Typewritten information added to these documents by the use of a hectographic ribbon will enable the whole document to be

copied within the machine. Signatures or other data written with special fountain-pen ink will also reproduce. This procedure is useful when letters are being sent abroad and it is known that further copies will be required after receipt.

There is a tendency for the copies produced by the damp-paper methods to dry in a somewhat crinkled condition. Drying frames are available which enable the copies to be dried slowly and therefore remain without crinkles. Small drying apparatus of the rotary type is also available for the same purpose.

The damp-paper process is designed for producing only a limited number of copies; indeed, as each successive copy grows fainter this limits the number of good readable copies obtainable.

The method is quite cheap to operate and is particularly useful for air-mail purposes, since letters or documents so prepared may be sent abroad where they can be reproduced on a suitable machine. The master can also be re-run a limited number of times.

While the copies produced by this method are satisfactory for many purposes, particularly of the telecommunication type, they lack the finished appearance given by other duplicating processes.

CHAPTER XXVI

THE HECTOGRAPHIC PROCESS

THE HECTOGRAPHIC PROCESS has long been available as a method of reproduction. Originally, in its simplest form, it used flat trays containing gelatine to which the dye of the printing image was transferred and a copy created when paper was placed in contact with it.

In its more modern form it employs rotary machines to which the hectographic master is attached. Paper sheets are then fed through the machine in rapid succession and, making contact with the master, produce the copies.

The master consists of a hectographic carbon sheet and a glazed sheet of paper. It is prepared by placing the hecto sheet beneath the glazed surface of the paper and then by typing, drawing or using letterpress or similar machines. The action of the typewriter key or other such means as may be used, transfers a layer of hectographic carbon deposit on to the underside of the glazed sheet, giving a reversed carbon image. This master sheet is attached to the spirit duplicating machine. The copy paper which is brought into contact with this image is first dampened by a quick-drying hecto fluid, which is a solvent medium. This spirit softens a fine layer of carbon deposit on the master, making it transferable to the paper and so providing a copy having a dye image.

The density of the carbon image on the master diminishes with each succeeding copy, thereby creating a limiting factor in the number of copies which can be obtained from each master. Normally the process is designed for short-run work of up to about 200 copies, but special masters are available which allow this number to be considerably extended.

A unique feature of this method, one not possible in any other known process, is that it is able to produce up to seven different colours at the same time. This is achieved by using carbon of different colours when preparing the master and so depositing a layer of carbon according to the colour used. Thus, if a line is typed or drawn using a red carbon, a second line using a blue carbon, and

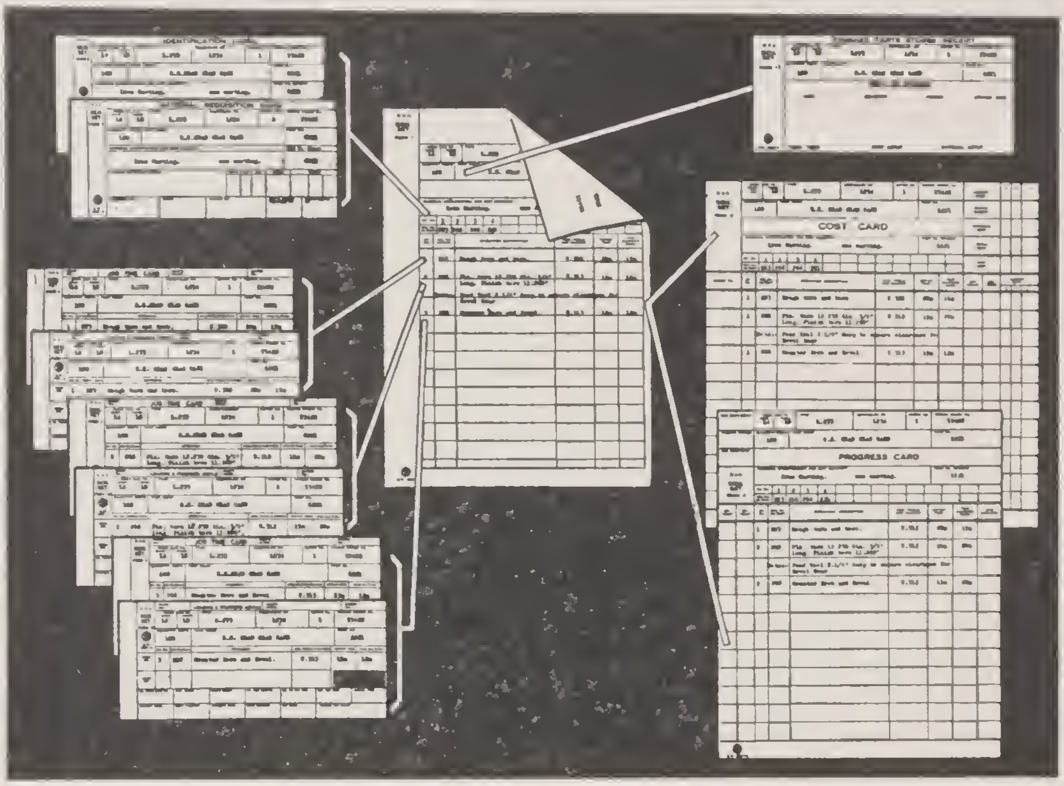


Fig. 26. The illustration above shows a set of typical Production Control Documents which have been reproduced from the typewritten Master. The machine makes possible the simultaneous reproduction on the ticket of the heading and any individual line of operation—each ticket is therefore only passed through the machine once. The Cost Card, Progress Card and tickets are all fed from the same table and are stacked and ejected to the front of the machine in correct order for issue.

Permission Block & Anderson.

a third line using a yellow carbon, the master will hold three lines of different colours. This coloured carbon deposit, when brought into contact with the moistened copy paper is made transferable by the solvent contained on the paper, and will therefore produce a multi-coloured copy. The quality of the copy so produced is not comparable with the colour reproductions given by some of the other duplicating processes, but it is normally satisfactory, is adequate for many applications, and is therefore a particularly useful one. Hecto carbon sheets are available in various sizes and are made in purple, green, red, blue, yellow, black and brown.

The machines available for the hectographic process cover a wide range, including both small portable hand-operated and fast electrically driven apparatus, some of which are equipped with special means for ejecting the master and selecting a new one

automatically. This facility reduces the 'make ready' time to a minimum, and, together with the cheapness of the printing master used, combine to make it an economical short-run process.

In addition to the normal range of hectographic duplicating machines, special apparatus is available having unusual features which allow the whole or part only of a typewritten master to be reproduced. Known as line selectors or dual-purpose system machines, they have been specially designed to minimize and simplify clerical effort by providing a mechanical means of issuing from one central point all the essential manufacturing information which is required to guide each job through every department.

These machines are able to reproduce individual lines or items from the master list and will therefore produce automatically all the documents required in modern production control. The extraction of specific information and its production on to individual sheets make these machines extremely useful where multiple records are necessary. They are applicable to every side of accounting, sales, purchase ledgers, costing, stock and analysis records and all forms of control systems. Some of these machines are able to do both normal duplicating and also systems work. Because of their usefulness in this important field, a range of these specialized machines is available, the latest addition being able to select the required lines electronically.

The hectographic process requires extreme care when making both the master and the copy, to avoid carbon stains. The introduction of stainless hecto sheets and other methods which are discussed later has done much to eliminate this objection. These stainless sheets are over-coated or sprayed with plastic and are clean to handle and use. They still, however, require care when corrections are being made because the typewriter key penetrates the protective layer. Special correcting fluids and erasers are available to minimize the risk of stain while making these corrections.

The copies produced by the hectographic process can be of good quality. They are not durable and will fade if exposed to strong daylight. The best results are produced from the purple carbon masters, but black carbon has now been introduced which gives a copy of good contrast, having an appearance more resembling that of the usual ink processes. The black carbon, however, will not produce runs of comparable length with the purple masters. The deep, mauve-grey carbon will also produce good results.

Methods of hectographic duplication which are claimed to give no stain, either when typing or duplicating, are now available. They employ colour-forming compounds which do not unite to form

colour until fluid is introduced by the duplicating machine. These methods are more fully discussed under Azograph and similar methods.

GELATINE (HECTOGRAPHIC)

In addition to the simple gelatine tray method of hectography previously mentioned, methods using gelatine in sheet or roll form are available in some countries. The following brief description of this method is appended chiefly for information.

The apparatus used in the gelatine process may be either of the flat-bed or rotary type. With the flat bed, the gelatine in roll form is stretched across the bed of the apparatus. It can be advanced to produce a clean sheet of gelatine when a new master is being laid down.

For use with the rotary machine, gelatine is supplied in thin flexible form which enables it to be fastened to the rotating cylinder.

The original master copy is made on any hard coated paper in contact with the hectographic ribbon. It can also be created by typing, writing or drawing on the paper with hectographic ink, crayon or pencil.

To make the copies, the master is first placed in contact with the gelatine and pressure is applied to transfer the dye to the gelatine. Paper brought into contact with this surface will produce a copy.

The dye deposited on the gelatine will gradually sink into the surface, thereby allowing it to be re-used after a period of about twenty hours.

Copies may be reproduced in the normal range of hectographic colours, the purple dye providing the best printing quality.

It is estimated that the flat-bed apparatus is able to do about ten to fifteen copies per minute and the rotary up to fifty copies a minute.

The process is cheap in materials but expensive in labour time and is suitable for only short runs up to about 100 copies.

AZOGRAPH, CHEMOGRAPH, BANDAGRAPH AND OTHER NON-STAINING SPIRIT METHODS

These processes, which belong to the spirit group, constitute an important development because they are designed to eliminate completely the stains usually associated with this method. This feature has been made possible by using dyes, usually of the diazo type, in the master sheet. These dyes are insoluble and therefore non-staining until a third chemical within the machine, or in the

copy paper, is brought into contact with them. The master sheets can therefore be handled and corrected with impunity, because any dye matter which may be transferred can be readily brushed off the hands without leaving any stain.

As with the normal type of hectography, the master is prepared by typing, writing, drawing or other means. Likewise the copies are made by attaching the master to the drum of the machine and dampening the copy paper with special fluid, to allow it to soften and transfer part of the image to it. With some of these methods, the fluid may be of the corrosive type and therefore can only be used for long periods in apparatus with stainless steel containers and bearings. With Chemograph, a special copy paper is required, because this contains a chemical necessary to create an image. Bandagraph also requires a copy paper having an alum content, but as this is found normally in most copy paper it does not constitute a serious disadvantage. The shelf life of some of these masters is also restricted and therefore deterioration will begin at an early stage, rendering them useless after a few months.

However, active development is being made in this field and it is expected that new methods will be introduced which will still retain the simplicity of the spirit process but eliminate the stain usually associated with it. As all these new and improved methods have a tendency to increase the cost of the masters, it is possible that they will prove to be less economical than the normal hectographic method.

CHAPTER XXVII

STENCIL DUPLICATION

THE STENCIL PROCESS has long been used as a method of preparing duplicated copies. The stencil master used in this method is made of a strong, fibrous coated tissue which is impervious to ink. When the surface of this stencil is cut with a typewriter or other means it allows the ink to penetrate, thereby producing a copy when the paper is brought into contact with it. The function of the machine is to ink the stencil and feed the paper beneath it to create the copies.

A stencil consists of an assembly of three sheets; the stencil, interleaving, and backing sheet. Guide marks are printed on the stencil to assist the typist in the general layout and allow her to keep within the selected area and give marginal space. Normally white in colour, stencils are available in various qualities, the better-quality stencils being designed for runs of greater length. The ordinary type of stencil is tested to give about 3,000 copies but quantities in excess of this figure are often obtainable. The life of a stencil is dependent on many factors, chiefly perhaps on its quality, but also on the extent of the cutting it has received both on the typewriter and particularly by the number of lines made by a ruling pen or stylo. The skill of the operator and the quality of the duplicating machine used are also important, but generally the higher-grade stencils will yield the longer runs.

Stencils are also available in a pre-sensitized form called photo-stencils, which can be prepared by photographic means from original copies, thus eliminating the necessity to retype. They are also obtainable coated with a coloured dye, usually yellow. These are called diapositives and are used to make offset lithographic plates.

Brush stencils are also available which, as their name suggests, are intended for brush preparation with a special ink fluid which dissolves away the stencil composition wherever it is applied. A round-pointed sable brush should be used for drawing and general purposes, and a chisel-point brush for broad or one-stroke lettering. These stencils will reproduce hand-lettered notices or illustrations

quickly and effectively. A squared over-print frame makes it easy to set up accurately all reproduction work. No additional processing is required, and a further texture can be added as contrast by the use of wheel pens and shading plates.

Brush stencils are not intended for typewriting but small areas may be typed before the solvent ink is used. The stencil ink available for use in the preparation of the stencil is easy to apply, dries quickly and is non-staining.

APPARATUS

The machines used in stencil duplication are of two types; flat bed and rotary. The flat bed machine consists of a wooden box containing a hinged frame carrying a silk or wire gauze sheet to which the stencil is attached, a base for the copy paper, a slate ink-bed and rubber roller. When making a copy the paper is laid on the base, the stencil is brought down in contact with the duplicating paper and the inked roller is passed over the silk sheet, providing an impression on the copy paper beneath it.

This method is extremely slow and suitable only for short runs. The advantages claimed for this type of apparatus are (*a*) that it can print on sheets larger than can be accommodated on rotary machines, (*b*) that it can give exact registration, and is therefore particularly suitable for colour or overprinting work. Recent developments have produced rotary machines capable of giving good registration, and these, together with the high cost of present-day labour, have rendered the flat-bed type obsolescent except for occasional or special use.

ROTARY MACHINES

The rotary machine may be hand or electrically driven. There are numerous models available, differing in principle according to the make of the machine.

Operating speeds up to 6,000 copies per hour are obtainable on some electric machines, but a reasonable production speed would be between 3,000 and 4,000 copies per hour. Very short runs, necessitating frequent change of stencils, would naturally reduce this figure considerably.

The need to replenish the small paper stack usually fitted to these machines and the frequent inking required have previously restricted their operational output. The introduction of automatic inking has provided a more economical method and saved time previously required for this operation.

STENCIL PREPARATION

The typewriter is normally used to prepare the stencil. The work should be undertaken by typists with the necessary experience, since a firm, even stroke is essential if good reproduction is required.

The use of transparent Cellophane in sheet or ribbon form will sharpen the copy, avoid cutting out the interiors of letters and keep the typewriter clean. This material is placed in front of the stencil, or the Cellophane ribbon is wound on the typewriter ribbon spool.

Carbon copies are obtainable by the normal methods and corrections on the stencil are made by painting over the error with a special fluid and then retyping. Stylo pens for creating lines on the stencil are also available in a wide selection of designs. These give a variety of line, both in width and dot formation.

Full details of the correct way to cut, handle and store stencils are issued by both stencil and typewriter manufacturers. These instructions should be carefully followed since a well-cut stencil can add considerably to the appearance of the final copy. The electric typewriting machines which give an even pressure automatically are to be preferred for this work and broad type-faces should be avoided.

Stencils can also be cut by a number of special machines, such as those of the tabulator type. The teleprinter has been adapted to use stencil in roll form, thus creating a master from which duplicated copies are easily obtainable. After use, stencils may be cleaned, filed and re-run when necessary.

The semi-absorbent type of paper usually necessary with this method of duplicating is a minor weakness, particularly where paper has subsequently to be written on in ink. Some modern papers, however, have a surface which will allow normal writing with pen and ink and do not require interleaving, a precaution previously necessary to prevent the impression of one sheet being transferred to the back of the succeeding copy.

Recently, special powders have been used with stencil duplicating methods to bring the printed matter into relief, simulating die-printing. This is done by dusting the printed image with a special powder immediately it leaves the machine. The sheets are then passed through a heater which causes the powder to fuse with the ink, giving an embossed effect to the letters and outlines. Used with special coloured powders, this can create effective and artistic results, or, when added to material printed in Braille characters, it can be read by the blind, thus providing, at cheap cost, a most useful and humane service.

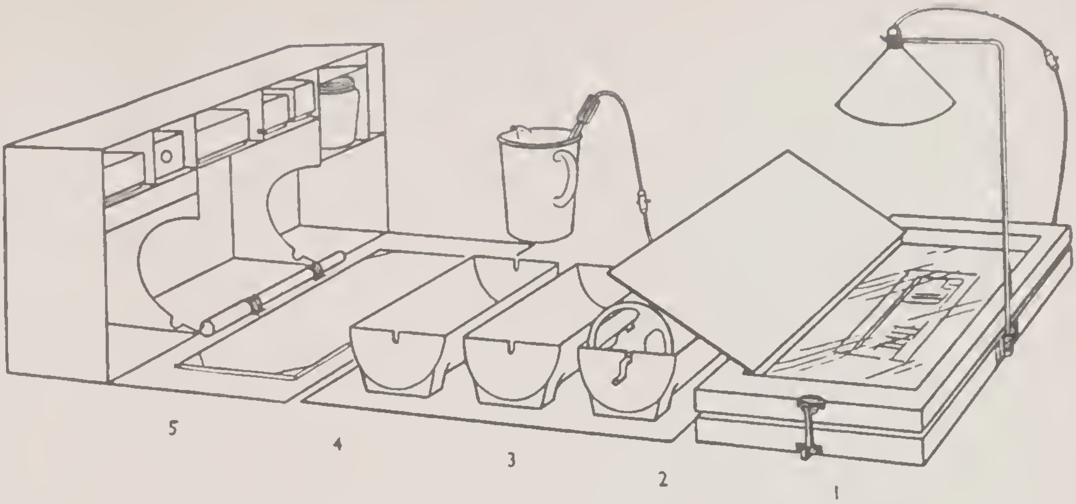


Fig. 27. Gesteprint office process. Sequence of operations.

PHOTOGRAPHIC STENCIL

A photographic stencil is a sensitized stencil which, by exposure to a positive original, produces on development a black stencil having transparent lines corresponding to the dark area of the original. It is used on the normal stencil machine, producing positive copies from positive originals. Available in two different degrees of sensitivity, one for use in normal office lighting, the other requiring a yellow safe-light, these stencils enable originals already in an acceptable form, e.g. line diagrams, charts, drawings, typewritten, letterpress and similar matter, to be copied and a stencil produced without retyping, drawing or other manual means.

Photo stencils which have a low sensitivity, and can therefore be made in the office, can only be created from positive originals which are translucent and have lines of good density. Where the original to be duplicated is not suitable for this method, an intermediary master must be prepared or one of the other methods, as described later, used.

The exposing and developing apparatus required for this work is obtainable from the stencil manufacturers and consists of exposing frame and photoflood lamp, together with three trays containing drums to which the stencils are attached for processing. The necessary chemicals are supplied in bottles with measures to simplify the procedure. After developing, conditioning and drying the photo stencil is ready for printing. For use with photo stencils of a higher sensitivity, apparatus has been designed which enables a photo stencil to be prepared from opaque originals. This apparatus is fitted with means for holding both the stencil and the original and has a

lens and light system. The original to be copied is placed in the lower holder and the sensitive stencil on the upper one. Exposure is made through the lens and when processed the sensitive stencil will produce positive copies by the stencil machine.

This special apparatus, which is known as the Photoscope, is available in two types, one of which is able to produce photo stencils of the same size only, the other model being able both to enlarge and to reduce from the size of the original. The useful feature of this machine is that it enables stencils to be made from opaque originals or double-sided copies. It is able to extend the scope of the stencil machine by permitting it to create stencils without retyping from existing originals, such as letters or printed matter or from drawings and similar material which cannot be prepared on the typewriter. Half-tone copies are also obtainable by the use of a special half-tone stencil screen.

Photo stencils are not difficult to make, and operators of average intelligence can be quickly taught how to prepare them. They do, however, require the right type of original and careful exposure, with processing undertaken at the correct temperature. Booklets which describe these methods are available from the manufacturers. These are fully illustrated and outline the process in detail, giving particulars of the exposures to be given. If these instuctions are carefully followed no difficulties should be experienced.

ELECTRONIC STENCILS

Stencils may also be cut by the use of an electronic machine, which in working principle is similar to facsimile transmission. The original to be copied is mounted on a cylinder which also holds the stencil. During rotation the original document is scanned by a beam of light, and the stencil is cut thermo-electrically, in accordance with the impulses received from the scanner. Opaque or double-sided originals, including continuous or half-tone photographs, can be copied by this method.

These electronic machines are expensive, but they extend the usefulness of the stencil process. They are discussed in the chapter on Facsimile Reproduction.

CHAPTER XXVIII

DIRECT LITHOGRAPHY

UNTIL RECENTLY direct lithography has not been used as an office process except in part by the Davidson machine. Recently, however, a small machine has been introduced which is able to print by direct lithography from both typed and photographically prepared plates. An ingenious method has been employed to overcome the difficulty of typing with reverse reading. Using a very thin metal plate with a sheet of greased carbon placed behind it the action of the typewriter key deposits a greasy lithographic image on the back of the plate. This image has reversed reading, the front of the plate reading correctly because it is prepared direct from the typewriter ribbon.

The plate is then attached to the machine, the front part being in contact with the rollers. The image on the reverse side after being inked will make copies when paper is brought into contact with it. It will be seen that the principle of typing resembles the hectographic process in which a hectographic carbon is placed behind a sheet of paper and produces by typing a reversed image on the master. The method of creating a copy, is, of course, entirely different.

When plates are prepared photographically the negative is reversed in the printing-down apparatus; this will also provide a reversed image. For this reason only thin films may be used unless the image had been made to read correctly by the use of a prism or other means when taking the negative. For this purpose the Photostat correct reading negative would be suitable.

The particular advantage claimed for the direct method of lithography as an office process is that it is especially suitable for short-run work, as the time of machine preparation is considerably reduced, because there is no offset blanket to clean down and the metal plates are quickly attached and withdrawn from the machine.

The process is also suitable for long-run work, the typewritten metal plates being able to produce 20,000 copies and the photographically made plates up to 50,000 copies.

The 'Lithoset' machine is made by Ormig in Germany but is available in other countries. It has most of the features fitted to other office printing machines but at present only takes paper 14 $\times$ 9 in. As with all lithographic processes it is able to produce a copy of good quality.

CHAPTER XXIX

OFFSET LITHOGRAPHY

LITHOGRAPHY is one of the major printing processes now widely used throughout the world. It is a method of printing from a surface image made by greasy ink on a moisture-retaining surface. Since water and grease will not mix the image attracts the greasy ink which is applied to it by the inking rollers on the machine, but water contained in the other areas repels the ink, thus allowing a copy to be made when paper is brought into contact with the image.

In its original form the ink was applied to a porous stone which was able to retain sufficient moisture to repel the ink in the unwanted areas. When greasy ink was rolled over the stone, it was accepted by the greasy image but repelled by the moistened part. When paper was laid in contact with the stone or rolled over it on a cylinder, the ink was transferred to it, thus creating a lithographic print. Later the stone was replaced by zinc or aluminium plates, their surfaces being finely grained to accept and retain either grease or water. Being flexible these metal plates could be positioned round a cylinder which led to the development of the large rotary lithographic machines now so widely used.

The diirect method of lithographic printing has one serious disadvantage in that it requires the image on the plates to be in reverse. For many applications this was inconvenient and eventually led to the development of offset lithography in which the image on the plate is first transferred (offset) on to a rubber-coated cylinder, technically known as a blanket, and then again offset from the blanket on to the copy paper.

There are many real advantages in the offset method, particularly for use as an office duplicating process. Perhaps the most important of these is that it allows the plate to be typed direct. Also the plates being light in weight, can be easily stored and kept available for instant use when required. They can be printed by photographic means in small apparatus without the need to reverse the image at any stage. Almost any weight of paper can be used from thin copy to heavy card.

Because of its usefulness as a reproduction process, small offset machines have been developed which are particularly suitable for office duplicating. To enable the process to be used economically also on short-run work, cheap paper and plastic plates have been introduced. Special founts and automatic cylinder cleaning devices have assisted in making the process competitive with other methods of reproduction. The metal plate is primarily intended for long-run work. The type of plate and also the method of coating used has a considerable influence on the number of copies it can be expected to produce. If the plates are prepared by the deep-etch or similar methods, the process can give runs far in excess of normal duplicating requirements.

The non-metal plates are obtainable in a range of qualities, each of which is designed to produce a number of copies, according to its price and quality. In practice, runs well in excess of the figures given by the manufacturers are obtainable. These cheap plates are easy to type and correct, and they have done much to reduce the initial cost of offset lithography and make it economical when only a few copies are required.

PREPARATION OF THE MASTER

The offset plate can be prepared by various methods. It can be typed directly by any typewriter using a fabric ribbon which is impregnated with a special greasy preparation for the formation of the image. This is perhaps the quickest and cheapest method of preparing a plate. The typewriter must be free of any grease. It should therefore not be used for preparing offset plates after cutting stencils unless it has been adequately cleaned. A hard platen should be used to avoid indentation of the master and where very sharp images are required the use of a one-time paper ribbon is an advantage.

Plates may also be prepared directly by drawing on them with a greasy pencil or special ballpoint pen or by any ordinary pen using greasy ink. The skill of the artist is the only limiting factor in the quality of work which can be reproduced, but the method is not difficult and with practice the result should be entirely satisfactory.

Numerous indirect methods may also be used. An image may be transferred from printers' type, any letterpress machine of the parallel platen type being suitable for this work.

The printing image made by the True to Scale (T.T.S.) process will also transfer an image to an offset plate which has been rolled in contact with it. Likewise, a stencil inked in a flat-bed machine can be used for the same purpose and by the same method. Rubber

stamps and numbering or similar machines, if using an oil base ink. will all produce an offset master which will reproduce satisfactorily.

PAPER PLATES

The paper plate can be prepared by writing machines or other methods, such as ruling, drawing, stamping or tracing through carbon paper. Special ballpoint pens, writing fluids, pencils and crayons are available for working directly on to the paper plate. The choice of the image materials is of importance, and those intended for the particular make of plate being used are normally to be preferred.

Any typewriter may be used and a choice of ribbons is available for the purpose. The mechanical condition of the typewriter may have some influence on the quality of the reproduction given, but it is essential that the type is kept thoroughly clean.

It would appear that some care is required when typing paper plates. The same natural stroke should be used as when typing ordinary paper. A heavy touch tends to indent the master, causing hollow characters. For this reason typists who have been accustomed to cutting stencils will often find difficulty in typing paper masters, owing to the heavy pressure they have acquired for stencil work.

The indentation caused by over-pressure will make corrections more difficult since the carbon is not easily removed from the deep grooves. This is particularly so when electric typewriters having extremely small type-face are used. Some of these are not really suitable for the work since they indent the material to an extent which makes good corrections almost impossible. It has been found that a sheet of Bexoid, as sold by Bex Plastics, if placed behind the plate when typing will greatly assist in preventing serious indentation, thereby enabling plates to be more easily corrected when required.

For correcting plates, both erasers and fluids are available. The Planifer Green Eraser sold by West Partners is particularly suitable for this purpose. Conventional erasers may contain a greasy substance and are therefore unsuitable. When making corrections use a lifting stroke and do not erase too deeply, otherwise it may remove the top coating and cause a smudge to appear on the duplicated copies—keep the eraser clean and after each stroke rub it on a sheet of clean paper to prevent the removed ink being transferred again to the surface of the master.

It would also appear that some difficulty is occasionally experienced when first using paper plates. There is a distinct difference in the method of printing paper plates which have been typed with a paper

ribbon. By their nature these ribbons contain only a small amount of rather hard grease, and it is necessary to run the ink fairly soft and more generously in quantity than is usual with, say, a photo-mechanically prepared plate; otherwise there is a tendency to print grey and for the corrections to wear off quickly.

In typing plates with a carbon paper ribbon, it is necessary to have the typewriter adjusted so that the ribbon moves along one complete space for each character typed. Half-inch ribbons are not always satisfactory and it is cheaper and more convenient to have a typewriter which can be equipped with a side attachment capable of accepting a large spool.

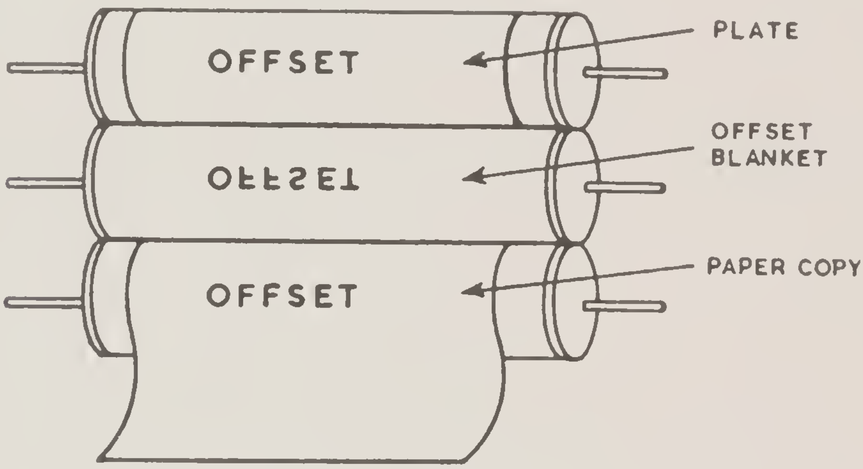


Fig. 28.

When paper plates are used in conjunction with a fabric ribbon excellent results can be obtained but where the sharpness and clarity of a paper ribbon are desired more care must be taken in preparation and reproduction.

To obtain consistent results with the offset process, some attention should be given to the storage of the ink used. Manufacturers of repute have prepared a well-balanced formula but the nature of this ink can readily be disturbed by excessive or prolonged exposure to heat and cold, high humidity and other conditions.

Such high temperatures as are found near radiators or hot pipes, or in the direct rays of the sun, may upset viscosity and when used in a cold condition these inks will give a decrease in colour strength.

It has been recommended that inks, especially black inks, should be stored for a reasonable length of time to improve their working qualities.

PHOTOGRAPHIC MASTERS

Lithographic plates may also be sensitized by special solutions or purchased in pre-sensitized form from the manufacturers. These sensitized plates are exposed in contact with a photographic negative or positive (according to the coating used) or a diapositive stencil. This type of stencil has been treated with a coloured dye, normally yellow, which acts as a barrier to the printing light, allowing it to pass through the cut parts of the stencil only and so form an image on the sensitized plate coating.

Some of the pre-sensitized plates which are available on both metal and non-metal bases are more sensitive to light than those coated with the popular albumen process. Owing to their greater sensitivity, they can be exposed by photo-flood (tungsten) light. Having photographic emulsion these plates may require handling in a yellow or other safe light but those having a diazo coating can be handled in room lighting. The diazo-coated plate requires for exposure a more powerful light of a cold cathode fluorescent or mercury vapour type. Diazo plates are also available having a negative or positive coating thus enabling a positive image to be produced from either a negative or a positive master. Photo-copying methods are also widely used to transfer an image directly to an offset plate. These processes, together with other methods of plate preparation, are discussed in a later chapter.

APPARATUS

The apparatus used in offset lithography is all of the rotary type and electrically driven. The cheaper models are usually friction fed but those designed to produce long runs have suction feed and some are fitted with an automatic ejection device to prevent two sheets being fed through the machine simultaneously.

Also available are machines which are able to print both the front and back of a copy, either consecutively or simultaneously. The Tandem machine of the Addressograph Multigraph Company is virtually two printing heads fitted to a common feed. Incorporating a tumbling device it is able to print both sides of the paper, or without this device to give two impressions, which may be of different colours, on the same side of the paper. This model is intended to produce two-colour work or to print both sides of the paper in a single run.

The Davidson machine is able to print by both direct and offset lithography. It can provide simultaneously an image by offset on

the front of the copy, and by direct printing, an impression on the reverse side. This is made possible by using two cylinders through which the copy paper is passed. The plate of the direct image presses the paper against the offset blanket so enabling an image to be printed from both printing surfaces, thereby printing both sides of the paper simultaneously. The machine is also able to print by the dry offset method, in which a relief image is offset to the blanket; the printing being done without the use of water, as is necessary in the normal offset method.

The maximum speed obtainable with the average offset litho machine is about 6,000 copies per hour but under normal conditions an output of 3,000 to 4,000 copies would be considered reasonable.

Originally, the offset process was considered only suitable for long-run work since it was felt that the make-ready time and the expensive metal plates used, made the initial costs high and the whole process therefore uneconomical for short run work. The introduction of the cheap paper plate with quick methods of attaching and removing the master from the machine, have now made it suitable for runs of very much shorter length than were previously economical.

The print quality given by offset lithography can be of a high standard. Prints may be prepared on the best quality paper if required and those produced from plates made by the Varityper or similar machines can reasonably be classed as 'near print'.

CHAPTER XXX

PLATE MAKING FOR PHOTO LITHOGRAPHY

PHOTO LITHOGRAPHY, an extension of the offset process, is a method of using sensitized emulsions to prepare plates by photographic means. Intermediate negatives and positives may be made by photography and printed down on plates coated with sensitive emulsion to create a printing plate from which lithographic copies may be produced.

The intermediates required for this work may be made in enlarged or reduced form by a camera or same size by one of the many available photocopying processes which will produce a negative or positive master of good quality.

Plate-making apparatus usually consists of a plate-coating machine known as a whirler and an exposing unit which has means of holding the negative and the plate in contact during exposure. When pre-sensitized plates are used, only the exposing unit is necessary, but other small items such as an illuminated retouching table may also be required.

The use of the large camera and photographic methods is discussed elsewhere in this book and alternative methods to this valuable but costly apparatus are suggested.

The Reflex process which has been extensively used for preparing masters is fully discussed in a chapter in the photocopying processes. Special materials are available for use with this method when preparing masters for photo lithography. One of these is Kodalith thin ortho paper which is valuable when copying very poor originals. This high contrast paper, together with a Kodalith developer and a red filter placed over the lights in the reflex box, will provide a negative of improved printing quality.

The orthochromatic paper must be handled in a safe light, the Wratten Series 1A giving the maximum amount of light which can be safely used. To obtain the maximum contrast development should be continued to finality and followed by a rinse in a stop bath to avoid any developer stains.

Providing no enlargement or reduction from the original size is required, the use of these materials means that the worker is independent of expensive camera equipment. He is also able to copy poor-quality originals successfully with these contrasty materials.

Methods of using the 'Photostat' Machine as a process camera for plate making are outlined in the chapter dealing with 'The Process Camera'. If this machine is employed to prepare an intermediate negative, the special grade TL paper should be used, as the correct reading negative cannot be printed in face contact with the sensitized plate. If thick paper is used, some spread may occur owing to the lack of contact between the two surfaces. The grade TL paper consists of a high-contrast emulsion on a translucent base. The efficiency of this material is, however, below that of the Kodalith type. If the prism is removed from the lens of the Photostat, the apparatus can then act as a camera. It will be necessary to provide an easel and lights in a vertical position. By this means negatives, both paper and film, may be produced.

The photocopying processes which produce a positive intermediate, can only be used with deep etch or other suitable coatings unless a negative is made from the positive foil.

Plates may also be prepared directly by some other photocopying processes. Because of the ease and cheapness with which they can be made and the length of run they are able to give, it may be reasonable to assume that when these processes are more widely available they will constitute a serious challenge to the long accepted techniques of plate making.

Among the photocopying processes which are able to make offset plates are:

Verifax. It may be remembered that this process is capable of transferring a developed image to a sheet of ordinary paper. If a paper offset plate is substituted, the image is transferred direct to the plate. It is possible by this process to make a plate from an original copy in 1 min. only.

To prepare the plate, the original is exposed in contact with Verifax paper and developed in the activator liquid. It is then rolled in contact with a paper offset plate by the aid of a small unit available for this purpose. The plate is then separated from the Verifax master and after being etched with a special solution it is ready for use.

Any typed, printed, drawn or written matter may be copied by mthis ethod, and half-tone reproductions printed by a coarse grain

screen may also be reproduced. The plates are able to produce over 5,000 copies of good quality.

Xerography. This method is now being widely used as a plate-making process. Special cameras have been introduced which are able to prepare a plate having an image of the same size or enlarged, or reduced from the size of the original. The latest camera made available for this work is able to copy from masters up to 17 × 20 in.

Recently introduced also is the Xerox Lith Master Tone Tray. It is said that this enables a wide range of subjects to be reproduced including half-tone illustrations.

As an indication of the cheapness of this process it has been stated by one of the large car manufacturers in the U.S.A. that they can produce the first copy from an offset master made by Xerography at a total cost of 37 cents as compared with 3 dollars 12 cents for the same copying made by the usual methods using a zinc plate. The cost of the Xerographic plate-making equipment is, however, costly in this country.

It is estimated that the cost of making a paper plate by Xerography is about 1s. 2d. which includes time and materials. This is considerably less than the normal method now employed.

Azoflex. The carbon transfer method recently introduced for use with this process, is able to make a paper offset plate. The original to be reproduced is exposed in the Azoflex (OCÉ) machine in contact with the transfer foil. By passing the exposed foil, together with an offset plate, through a water bath and bringing them finally into contact the carbon image is transferred from the foil to the offset plate. As this method has not yet been widely used, comprehensive information is not available, but both the speed and material cost indicate that it will be extremely economical, and provide plates which are able to produce many thousands of copies.

Facsimile. Mention should also be made of the method of preparing plates by means of facsimile or engraving machines. Important in this field are the Fairchild Scan-o-graver and the Scan-o-Sizer. Using a plastic plate, the Scan-o-Sizer is able both to enlarge and to reduce as much as 4½ times and produce half-tones up to 12 × 16 in. The selection of screen sizes is automatic, screens of 65, 85, 100 and 120 lines being available.

Incorporated also is a device which allows reverse blocks to be made, thus producing white lines on a black ground. The use of this type of machine enables original copies already in an acceptable form to be scanned and a plate cut ready for use on the machine. The original may consist of both line and half-tone.

The Stenofax was originally designed for stencil preparation. It consists of two drums, rotating at the same time. An electric eye scans the original copy held on one drum, and transmits the result to an electric needle, which perforates a stencil on the other drum. It will also prepare in six minutes a master for the offset process, the size of the reproducible copy area being $8\frac{1}{2} \times 14$ in.

Pre-sensitized Plates. Plates which have been sensitized by the manufacturers are generally referred to as pre-sensitized. The steady increase in office lithographic printing has encouraged their development and they are now available in a wide range of sensitivities on both paper and metal. Many of these are coated with diazo compounds, and may therefore be handled in daylight. The pre-sensitized plates are able to give runs varying in length according to the quality used, some producing runs beyond the normal economic limits of the small offset machine.

The Kodak Lithofoil is stated to give runs of at least 25,000 impressions. This plate consists of a thin aluminium sheet coated with a light-sensitive layer. Under normal conditions it can be stored for periods up to eighteen months. Being of greater sensitivity than the albumen plate, it must be handled in subdued daylight or artificial light.

Exposure is made by contact with a negative image to light sources which are rich in blue, high pressure mercury vapour lamps being particularly suitable.

After exposure it is treated with a dilute alkaline solution and to give a more durable image, is then immersed in a stabilizing solution.

The method of preparation is not difficult and the quality of the image produced is adequate even for short-run colour work.

Exposing units are available for use with all these pre-coated plates. These are able to give good contact over the whole plate surface and incorporate a powerful light source, to enable the exposing time to be reasonably short. They are normally quite small and compact, and particularly suitable for use with the minor offset machines.

After exposure, the plates are developed with a proprietary solution or solutions and are then ready for use. The preparation of a pre-sensitized plate is usually a simple and speedy operation and owing to this they have become extremely popular for use in the office. They have a higher initial cost than that of the self-coated plate but considering their operational speed, and the reduced labour costs the overall cost may in some circumstances be cheaper than those prepared by the standard methods of plate-making.

The main advantage, however, of pre-sensitized plates is their convenience in a small unit lacking space and other facilities required with the normal methods of plate-making.

Plate sensitizing. There are a number of well-known sensitizers which are frequently used for making plates for the offset machines. Perhaps the most widely used of these is the albumen bichromate coating. The formula is readily available for those who wish to make their own, and proprietary liquids are supplied by all the plate and machine manufacturers.

The main constituent of this coating is egg albumen, which is usually dehydrated and supplied in flake form. When mixing, it is preferable to make only sufficient stock solution for a week's supply, since it deteriorates and loses its value as a printing medium.

The other important ingredient is ammonium bichromate, which is the sensitizing agent. This should be well filtered and when added to the albumen will require the addition of sufficient ammonia to turn the solution to a light straw colour. The sensitivity, or the speed of the coating, is determined by the ratio of albumen to bichromate which is normally four to one.

The sensitized solution is applied to a pre-dampened plate while it is being rotated in the whirling machine. Rotation speed is normally about 100 revolutions per minute, but may vary according to the grain of the plate. As the plate dries the coating slowly becomes insoluble and when exposed to a powerful light through the photographic negative or other master, the parts receiving the light rays are selectively hardened.

After being exposed, the plate is evenly coated with a thin layer of developing ink and then placed in tepid water, when the soluble albumen which was unaffected by light during exposure is removed by gentle rubbing with cotton-wool. At this stage unwanted parts or faults may be removed by an eraser.

When the plate has been etched and washed, it is gummed to preserve the moisture-retaining property of the grain in the non-printing areas. It has been strongly recommended by expert plate-makers that a plate should be left for ten to fifteen minutes between drying and printing. This allows it to gain equilibrium with the room atmosphere and will produce improved results.

The albumen plate is normally able to give runs of many thousands of copies and is suitable for most of the requirements in minor offset lithography.

Deep Etch. The deep etch method of plate making has recently been more widely used because of the quality of copy it can give,

and the increased number of prints it will produce. The term deep etch is actually a misnomer since it would be impossible to deep etch the thin plate used on the small offset machines. Whilst the actual depth of etching is approximately only 1,000th in. the term indicates to some extent the broad difference between this and the albumen method. With albumen the image is established on the surface of the plate but with deep etch the image has been etched into the plate itself providing a trough in which the ink is held. It will be readily seen that while the albumen surface coating may be worn away during a long run, with deep etch the ink is virtually bonded directly with the metal and will therefore not deteriorate in the same way, but may be expected to give good-quality impressions over extremely long runs.

The essential difference in the preparation of a plate for the deep etch method is that the plate is exposed in contact with a positive master. The protected image will therefore be the limited line or printed areas and not the broad areas of the original which are usually protected by a negative. The soluble portion is then removed, the lines being etched to provide a bond for the ink which gives the deep-etch process its long run qualities.

A number of formulae for the deep-etch method have been published and many proprietary processes are also available. The coating consists of a gum bichromate solution which should be whirled on to the wet plate at a speed of sixty to seventy revolutions per minute. The plate is then exposed in contact with the positive master. This exposure hardens the unprotected areas but leaves unhardened the image areas protected by the line on the master. This soluble image is then removed by the application of calcium chloride and the plate is etched by a weak acid solution. After the plate has been cleaned with spirit it is then covered with a lacquer and inked up with a suitable developing ink which adheres strongly to the lacquer. At this stage an inked image has been formed on the actual metal of the plate; a wash in water, accompanied by gentle scrubbing, will remove the coating from the plate background. The image-line is then further strengthened by the application of asphaltum, and the plate is finally coated with a thin preservative layer of gum.

Broadly it will be found that the coating for this method being somewhat thicker than for albumen, requires a longer exposure time. This is determined by the nature of the coating and the quality of the positive used and can only be assessed by adequate experience.

During hot and humid weather, deep etch plate-making can be troublesome, causing a partial breakdown of the image which is

due to moisture on the plate surface. Patra has introduced certain mixtures which will overcome this difficulty.

It should always be remembered that the purpose of plate-making by any process is to create a plate which will print good quality copies but will also continue to yield prints of a high quality throughout its required life.

The principles of plate-making are simple, and instructions are not difficult to follow but it is inevitable that a process which depends on various chemical and physical reactions is therefore subject to many variables in all its stages and so requires not only practical skill but also some sound knowledge of the fundamentals associated with this work.

To this end, work should wherever possible be done by competent and experienced staff. The special courses now being given by all schools of graphic art are of particular value to those employed on these techniques and the work of Patra in the examination of the problems which may arise is a most valuable contribution in this field.

The plate may perhaps be regarded as the heart of the offset machine. If it is faulty and unsuitable, much valuable and expensive time will be consumed by the machine operator in his efforts to prepare prints of good quality from an inadequate printing master. To avoid this waste of time, energy and expense, it cannot be too strongly emphasized that when the use of the offset machine is extended to include photo lithography, the preparation of the plate should be given adequate consideration and suitable training arranged for all staff employed on this work.

The transfer method of photocopying has now been extended to provide a simple and reasonably economic method of making metal plates for offset lithography. Being a contact method it is limited to same size copies but reducing methods can be used to provide an original of a suitable size. This method is more fully described on page 77.

Available in the U.S.A. is the Ektalith method which uses a very sensitive plate of the Verifax type. This is exposed by projection, and then transferred direct to a paper Ektalith plate for use on the offset lithographic machine. The method is described in the appendices.

CHAPTER XXXI

TYPESET RELIEF MACHINES

MACHINES WHICH USE printer's type having the image raised or in relief are available for use in reproduction work, and these are usually referred to as relief or letterpress duplicator machines. This apparatus varies considerably in design and size, being both of the flat-bed and rotary kind. Some of the simpler machines in this range are small miniature printing machines which, although toy-like in appearance, are able to produce work of a fine quality at reasonable speeds. The range also includes larger machines which are power-operated. The rotary machines are electrically driven and are able to print at speeds comparable with other duplicating machines, although not at comparable costs.

The printer's type used with this apparatus is set into a chase (an open frame) for use with the flat-bed models and in a cylinder or drum in the rotary apparatus. A wide variety of type is available for these machines, the type being supplied in sizes varying from 6 to 48 points. Modern type is made according to a measure called a point, which is approximately 1/72nd of an inch. Beyond 72 points, in the wood poster type, it is frequently referred to as a line, there being six lines to the inch.

Type is supplied in founts or fonts. A fount of type consists of a complete alphabet, but the number of sets of each letter varies according to the frequency with which it is likely to be required. The fount is also sub-divided into what are termed upper and lower case founts, the upper case consisting of capital letters and the lower case of small letters. There are many faces or styles, each known by a different name. These basic types can be sub-divided to styles which have a general resemblance to them, but retain their own special characteristics. Thus in the Gill family there is Gill Light, Gill Sans, Gill Sans Bold, Gill Sans Italic, etc.

In addition to using relief type, these machines are able to print from printer's blocks, zincos or electros which have been commercially prepared. The flat-bed apparatus can also print from lino-cuts and similar masters which are easily made by hand. They

are therefore useful for limited reproduction work, and, in addition, for educational purposes and the creation of simple artistic reproductions.

For these machines, type is set manually, an operation which is slow and somewhat costly in comparison with typewriter methods. With the flat-bed apparatus it is set in the chase, together with any zincos or blocks which may be included.

The rotary type of machine is fitted with a cylinder, having segments which may be either horizontal or vertical. These are prepared for printing by inserting the type into a composing fork which, on completion of the line, is then inserted into the segments, spaced and justified as required. As with all relief printing processes, the type must be set in the reverse order, so that it will read correctly on the copy made by direct printing.

Machines of this class can, in addition to printing from ink, be made to print from a carbon or fabric ribbon and will therefore produce copies which have the appearance of a typewritten document. Using a typewriter having the same type face, the name of the receiver can be inserted on the copy, which then resembles an individually typed letter. This method is extensively used in large business houses to give the individual touch to a mass-produced circular letter.

Printer's ink, being available in a wide variety of colours, enables multi-colour runs to be made by the usual method of passing the copy through the machine for each colour. The use of a number of cylinders each prepared for the various colours used in the copy will facilitate this type of work.

Typeset machines are useful in reproduction work because they are able to give an unlimited number of copies of forms, letterheads and similar documents. They are frequently used to overprint pre-printed copy, where an exact match with the printed type is required. By using the large metal type which is available, they are able to print bold headings for report covers and similar documents. When special typewriters are not available, these machines can be used to prepare a copy on good-quality paper which can be photographically copied and transferred to an offset plate or photographic stencil for reproduction.

The relief type can be obtained in different sizes, generally from 6 to 48 points. The flat-bed machines are able to take any sizes of type, but in the small apparatus it is normally restricted to about fifteen lines ($2\frac{1}{2}$ in.). Special zincos, electros and other printing blocks can also be supplied by the machine suppliers or trade houses, and these, together with the varying sizes of

type face, enable work of the highest quality to be produced on good paper.

A duplicating machine printing from relief impressions created by a typewriter has been introduced in Germany and is available in many countries. It is able to print from metal foils, rubber stereos or blocks, both line and tone. The stereos are normally supplied commercially, but the materials necessary for their preparation can be obtained if required.

The thin metal sheet or foil is embossed by the typewriter or stylo pen, causing the image to appear on the back of the sheet in reverse writing. This foil is attached to the cylinder on the machine and ink is applied to the back of the sheet. Copies are produced directly from the reverse side of the foil, thereby providing correct reading prints.

The metal sheets can also be embossed by printer's type to produce letterheadings, forms, or preprinted masters. Correcting instruments are available for making corrections on the foil. These machines have a maximum operating speed of about 6,500 copies per hour.

The normal relief type of duplicator is designed for special work, and is not intended to compete with other duplicating processes in speed or in economy Their usefulness lies in their ability to do certain work which cannot be done by other methods.

CHAPTER XXXII

PRINTING PROCESSES

THIS BOOK is intended to deal only with the simpler printing processes, which can properly be classed as duplicators. The following brief description of the major printing methods is given only as background information to help the reader who is not already familiar with the processes. There are three fundamental printing methods in commercial use at the present time, namely, letterpress, gravure and lithography.

LETTERPRESS

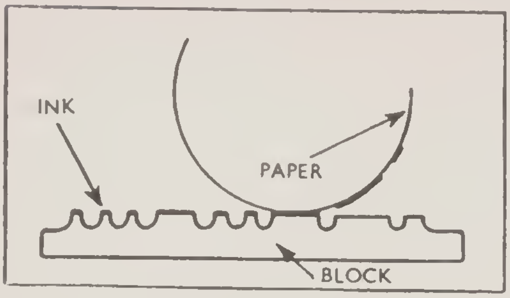
Letterpress is the oldest-known process. It is often called relief printing, since it is a method of printing from a raised metal surface, either type or blocks. Ink is applied to the raised surface and is transferred to the copy paper when brought into contact with it. Most newspapers and books are printed by the letterpress process.

There are specimens of relief printing, done with carved, wooden blocks, which date back to the eighth century. Printing from movable type appeared about 1450, and Johannes Gutenberg of Germany is generally credited with this invention, and also with the first printed book of importance, the Gutenberg Bible.

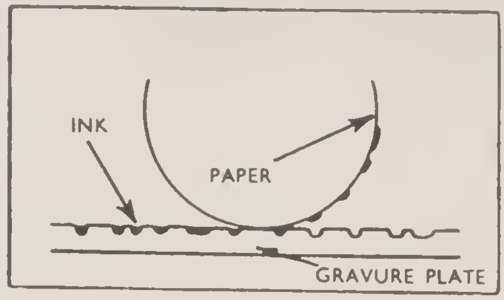
History records that his first press was converted from an old cider press, the type being inked by dipping a woollen ball in thick ink and lightly coating the type face. Compared with modern machines which print up to 50,000 complete newspapers in one hour, this was an extremely slow process. The second remarkable development in relief printing was the introduction of a mechanical line-casting machine, called a Linotype, which enabled type to be set more speedily.

Thirty-six years after the death of Gutenberg, a monument was erected in his honour, bearing the inscription 'He who first of all discovered how to print letters with copper, for this invention has earned the praise of the whole world.'

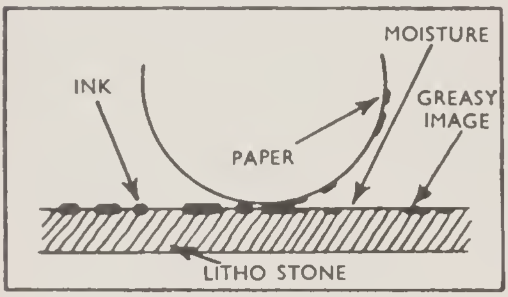
Indeed of all the inventions that have become a tool of human



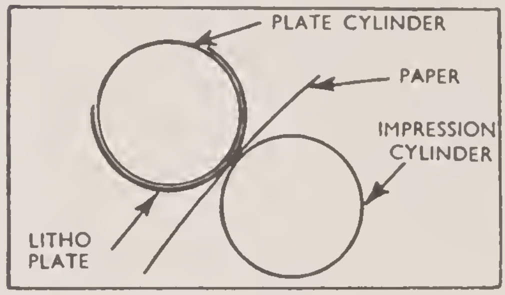
(*a*) *Letterpress*



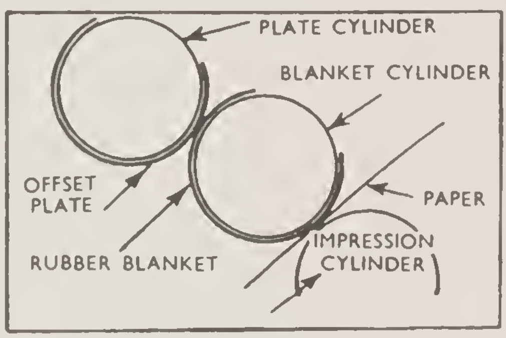
(*b*) *Gravure*



(*c*) *Direct Litho* (*Flat*)



(*d*) *Direct Litho* (*Rotary*)



(*e*) *Offset*

Fig. 29.

progress, it can be said perhaps that few are of greater importance than printing.

GRAVURE

In this process, the image is etched into the plate and therefore printing is done from an intaglio surface, which is the opposite of relief printing. The plate surface is coated completely with a layer of thin ink and then wiped clean, leaving the etched depression filled with ink. When the copy paper is brought into contact with the cylinder, the ink in the depression is pulled on to the sheet. This

method is normally used only for long-run work, since the original cost of the plate is high.

LITHOGRAPHY

This process differs from the other two by printing from a flat surface on which an image has been impressed with greasy ink. Until about the year 1900, lithographic printing was done from stone slabs, from which it drived its name – Lithos-Graphe – which are the Greek words for stone-writing. An early lithographer discovered that an impression which had been accidentally offset on to a roller within the machine produced a print of finer quality than that given by the direct image. The lithographic press was then designed to transfer the litho image to a hard rubber blanket, and then to offset this image finally to the copy paper. This method is now widely used and is known as offset lithography.

These points are perhaps more clearly illustrated in the accompanying diagrams.

PART FOUR

CHAPTER XXXIII

ADDRESSING MACHINES AND TECHNIQUES

THE GENERAL PURPOSE of addressing equipment is to produce one or a few copies from a number of masters on repeated occasions. The method therefore differs in principle from the duplicating processes previously described, which are generally intended to produce many copies on a single occasion, from one printing master. The machines used in addressing techniques are therefore designed to pass a large number of printing masters singly through a printing head, allowing them to be printed once or repeat printed if necessary. They also permit masters not required for printing to be passed (skipped) through the machine without being printed.

Originally designed, as their title implies, for addressing envelopes to people who had to be mailed on repeated occasions, the use of addressing machines has now been extended and can now be used in business systems, such as pay envelopes, payroll registers, production schedules and other factory and office procedures.

Included in the more recent developments are machines able to print circular letters which include the name and address of each recipient. More recently, punched-card tabulators and addressing machines have been linked to provide, according to coded cards, extensive lists which by manual methods would take many hours to prepare.

The printing master used with addressing machines consists of either a small rectangular metal plate, a stencil or a hectographic slip, according to the type or make of machine used.

There are two systems available in this country using metal plates. One consists of a single-piece plate, the other of an outer frame into which is inserted a small metal plate, together with a card strip bearing an imprint from the plate.

The stencil master is a specially impregnated fabric mounted in a three-ply manilla frame. The hectographic master is prepared on a roll of art paper which is perforated at intervals, allowing each to be detached from the roll and inserted into a plastic frame.

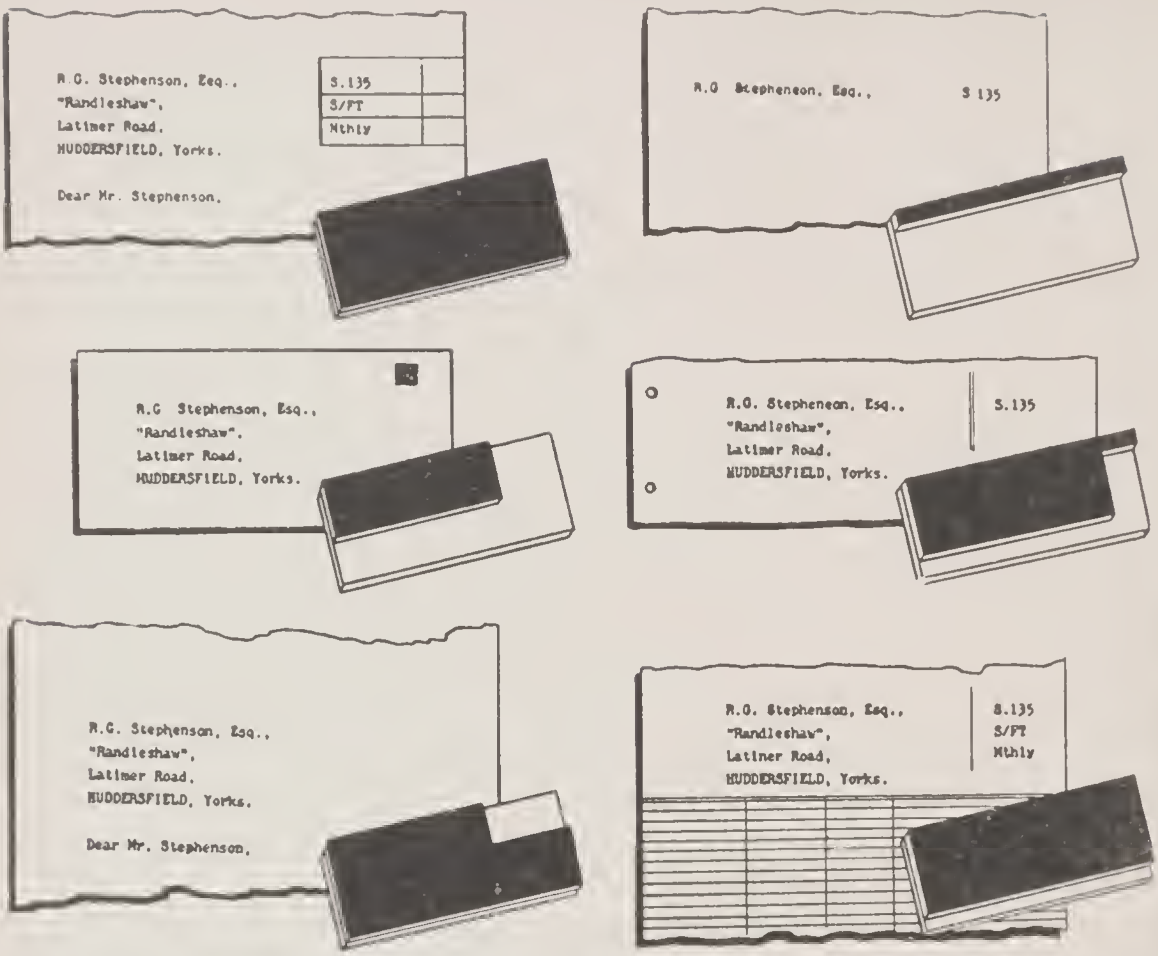


Fig. 30.

Addressing masters vary in size, the metal plate having space for up to nine lines of information with forty-six characters per line. In the stencil range, one is available for library work which is 5 × 3 in. and is able to accommodate fifteen lines.

The information to be reproduced is impressed on the metal plate by an embossing machine, which gives a raised type-face. This, when printed through a fabric ribbon within the machine, produces a copy similar to that given by actual typewriting.

A wide range of embossing machines is available, which includes both the simple hand-operated and electrically driven models which have keyboard operation. The smaller models are normally operated by turning a wheel to select the required character. Pressure is then applied to the plate mechanically, by hand, lever or treadle operation. 'Blanker' dies are included to blank out any error or to remove completely the embossed information from the plate, thus allowing the flattened plate to be re-used. It is generally found that a plate may not be corrected more than about five times.

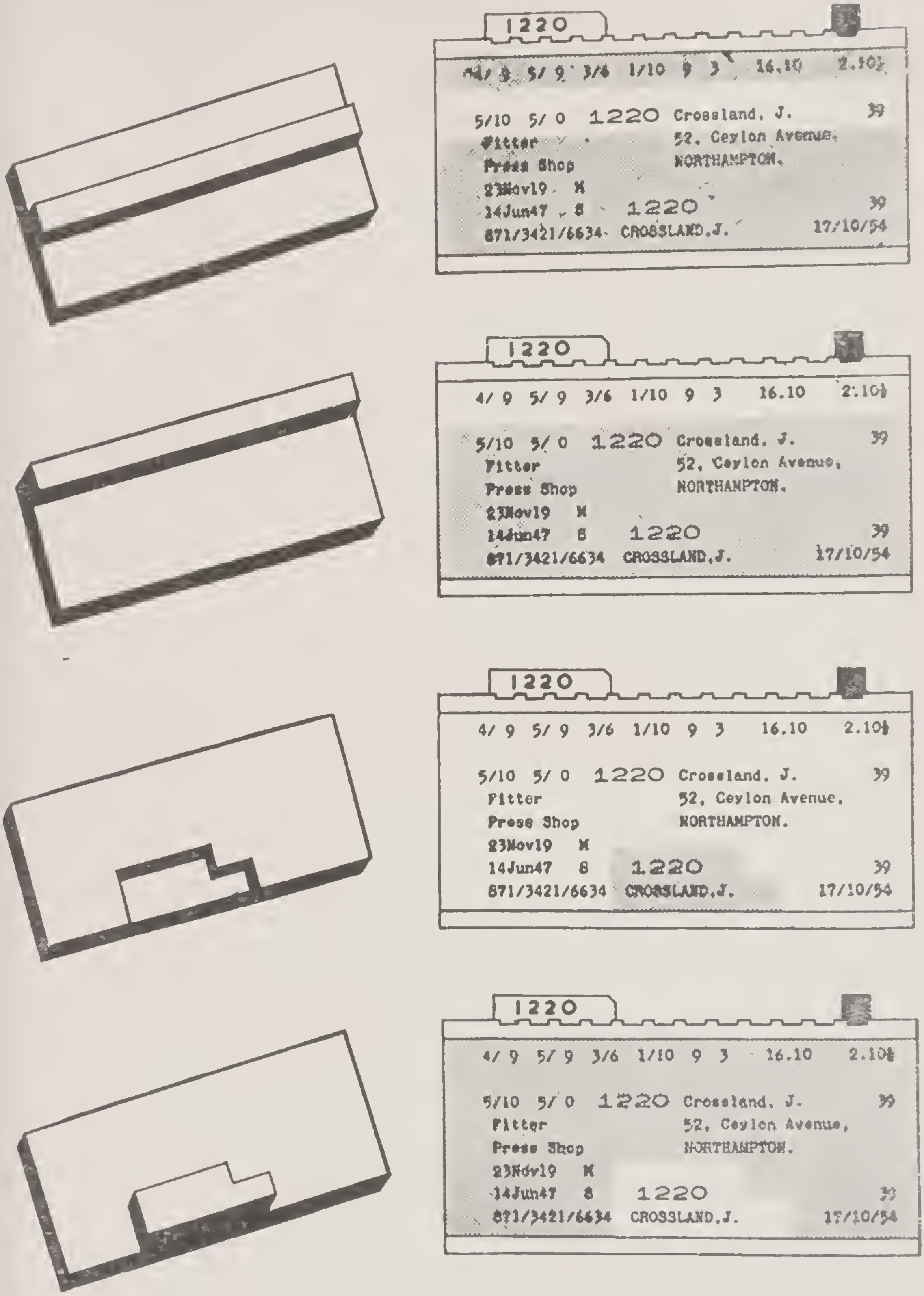


Fig. 31. This illustration shows how the cut-out pads are used to print the relevant information on the associated forms of a three in one copywriting set. Predetermined pressure control ensures a clean and even print at every impression. Excellent carbon copies are obtained.

Both the stencil and hectographic masters are prepared on a typewriter and printed as previously described for these two processes. When preparing the stencil master a small holder is required to keep the stencil in position. Where the typewriter is used continuously for this purpose, a special attachment is available which may be permanently affixed to the typewriter. The stencils are corrected by the use of correcting fluid. The frames holding the stencil can also be resilked, this being considerably cheaper than the purchase of new stencils.

No holder is required for preparing the hectographic masters. The plastic frames into which these are inserted are available in a variety of colours which aid visual selection. The hectographic master has a more limited life than either the stencil or the metal plate. It can be corrected in the normal manner. The preparation of the master is not expensive, and as these are not attached to the plastic frame are readily interchangeable and easily replaced when necessary.

METHODS OF PRINTING

The metal plate is printed by pressure contact through a fabric ribbon to the receiving material. The platens are flat, ensuring clean, uniform results, and reproducing all the required information by one impression.

Any portion of the plate may be selected for printing simply by using a pad, cut and shaped to make contact with the area required to be printed. Where several different though related forms require varying information from the same plates, pads are individually cut to allow the reproduction of the information required on each form. These pads can be quickly interchanged, and where additional information is required to that contained on the plate, this information can be printed by the use of loose type, lino slugs, line blocks, stereos and numbering boxes, which can be accommodated in the printing bed. Any part of the plate, together with this additional information, can be printed by the same impression, the appropriate cut-outs being quickly inserted into the printing head.

A number of attachments, both semi- and fully automatic, are also available to enable different impressions to be made on the same form in the appropriate columns. These attachments will enable machines to reproduce from one plate all the selected data on to individual forms, such as pay envelopes and clock cards, or in columnar listed style, pay-sheets and similar documents.

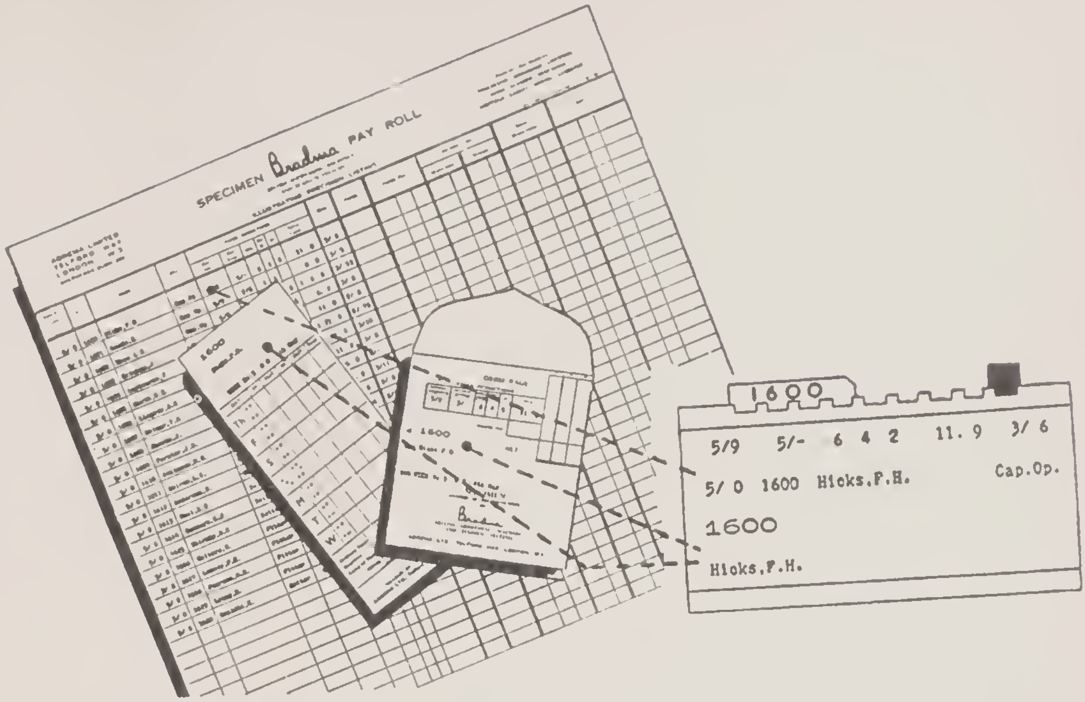


Fig. 32. This illustration is of the smaller Bradma 2RT one-piece metal plate embossed with details for a less complex payroll system.

Permission Bradma Ltd.

APPARATUS AVAILABLE

The machines available for addressing procedures range from those operated by hand to highly complex electrically driven apparatus. One of extremely simple design using the hectographic method consists of a double-headed manual device with a centre container of hectocarbon solvent, in contact with a felt pad on one side and a rubber roller on the other side. The pad, moistened by the fluid, is used to dampen the envelope or other matter being printed. The master is then placed over the moistened part and pressed into contact by the roller, causing an impression to be produced from the hectographic ink.

Specialist machines designed for specific purposes are obtainable and, because of the increasing usefulness of the addressing method, it is not unusual to adapt existing machines to do a particular type of work.

A most valuable feature in addressing technique is the facility to skip or print masters as required, using manual or mechanical methods. Masters required to be printed for small runs may be selected by visual inspection of a colour code on the master. Where selection is a regular part of the process and large quantities of masters are involved, an automatic selection device will relieve the

operator of tedious manual work and justify the expense of the device by the time saved in the process.

To assist in mechanical selection, metal plates can be fitted with tabs or have notches embossed on the plate surround. The card frame of the stencil master can also be punched according to a code, some of the larger cards allowing many spaces for this purpose. Automatic devices are provided in the more elaborate machines which enable groups of masters to be printed or skipped as desired.

An example of their usefulness may be quoted where a large store wishes to circularize its account customers with an invitation to a fashion display. The selection device could be made to select only the female customers, who would be more interested generally in this display. If, for certain reasons, it was desirable to limit the invitations only to town customers the selection device could also eliminate country customers outside a predetermined area.

Whilst methods of selection vary according to the type and make of the apparatus, the principle is similar in all cases.

The type of work done by addressing machines has in recent years been extended to include what may be classed as reproduction. Machines are now available which, in the example quoted above, could not only print the name and address of the recipient on the invitation card or envelope, but could also, at the same time, print the invitation card.

The reproduction head on this type of addressing machine is prepared by embossing strips of metal, using the same embossing machine as for plates. These strips are attached to a drum and printed through a fabric ribbon, so that the result resembles a typewritten copy. A signature block may be attached which will sign the document from an ink pad.

Machines are also available which can print a master document and a series of co-related unit documents with information concerned in the manufacture or processing of a given item. The widely used system of production control previously described with special line selection hectographic machines has therefore, by these methods, been extended to addressing techniques.

The development from the simple original purpose of addressing machines to the more extended techniques now being used indicates the usefulness of this method and points to the wider fields to which it may eventually be applied.

CHAPTER XXXIV

FACSIMILE REPRODUCTION

THE facsimile process normally consists of a means of transmitting a visual image from a transmitter to a receiver, which may be widely separated from each other or contained on a common shaft within the same machine. It can produce one or more opaque copies or a printing master from originals which may consist of written, printed or drawn matter, photographs, or other material.

The facsimile process, although essentially a communications method, has interesting applications in the field of reproduction. Progressive developments now being made in this process indicate that many of the future important contributions to be made in office duplication may result from the increasing use of and the experience now being gained from these methods.

Perhaps the most important contribution in this growing field has been the use of facsimile equipment to prepare masters for both the stencil and the offset processes. The quality of the image obtained from both line and tone originals suggests that its use in this direction might be extended and printing masters for other processes may likewise be prepared by these methods.

The machine used for making printing masters is fitted with two drums on a common shaft. The material to be copied is attached to one drum and the reproduction master to the other. As these rotate, a beam of light scans the copy activating a photo-electric cell and generating an electric current which is influenced by the light intensity. When the current is transmitted to the receiving instrument it controls a synchronized stylus which, as the drum revolves, creates a duplicate copy of the original or a printing master for either the offset or the stencil process. The minimum time required for the faster machines is about 3 min., but offset masters and stencils require much longer and vary according to the size of the original. Some of the slower machines which record with an exceptionally fine screen may require up to 20 min. to scan a copy 12 × 10 in.

The Roneo machine is well known in this field, but it is not

available for purchase. A service is given by Roneo Ltd. who will prepare electronic stencils from all types of originals.

The Rex rotary is reasonable in price and able to cut stencils from all kinds of material including line drawings and photographs. Stencils prepared by this machine are stated to give runs of 10,000 copies.

The Times Stenafax is able to prepare automatically a stencil or offset master in 6 min. It will, in addition, produce single positive copies on a special recording paper in 3 min.

The Fairchild electronic equipment, well known in the printing trade, is available in two models which are suitable for making reproduction masters. The Scanograver is the standard model, having a 65- and 85-line screen. It is limited to a maximum engraving size of 80 sq. in. The Scanosizer is able both to enlarge and to reduce as much as four and a half times and produces masters up to $12 \times 16\frac{1}{2}$ in. It is available with four screen sizes, 65, 85, 100, 120 and will produce masters, including half-tone, automatically on plastic plates direct from the original. A number of special features are contained in this machine which enable it to obtain extremely high contrast when required and to make reverse blocks, having a white line on a black ground.

Facsimile machines which produce opaque copies are also available. The time required to scan the original and therefore produce a copy has previously been a limiting factor in their usefulness for this purpose, but more recent developments which are able to overcome these former objections may do much to develop facsimile methods as a document-copying process when one or a few copies only are required. There are various types of recording papers. Perhaps those most widely used are the Teledeltos and the Timesfax. These are similar papers having a surface of white, grey or light-coloured tints, such as pink or yellow. The image is created by means of a thermal current which cuts the paper as the stylus moves across it. Where the surface coat has been penetrated the dark undercoating shows through, thus forming an image.

Among the machines which are able to produce opaque copies are:

Mufax. The Mufax is a self-contained unit which is able both to transmit and to receive. In practice, two of these units are necessary, one at each end of the line. The receiver is loaded with a 100 ft. roll of electro-sensitized paper and the transmitter contains the message which is wrapped round the drum. It may be handwritten in ink or pencil, or typewritten and is contained on a form $7\frac{1}{2} \times 5$ in. With

the average single-space typing, this will be sufficient for about 300 words and will take about 2 min. 7 sec. to transmit. The message is photo-electrically scanned at 75 lines per inch and is recorded on opaque paper by the receiver. It is able to produce only one copy; if additional prints are necessary they must be either re-scanned or prepared by other photo-copying methods.

Deskfax. This machine is also a small transmitter and receiver, taking forms up to $6\frac{1}{2} \times 4\frac{1}{2}$ in., which can contain up to 150 words, the scanning time being about $2\frac{1}{2}$ min. The message received is produced on inexpensive, dry recording paper, which does not require processing and is unaffected by light, temperature or humidity conditions. The operation is extremely simple and consists merely of attaching the message to the drum. The machine will then scan the message and reproduce a facsimile copy on the receiver.

Intrafax follows the principle of most machines of this type by producing a copy on Teledeltos paper.

Lithofax, however, creates a copy which forms an ink-receptive image that can be used as an offset master for reproducing up to 1,000 additional copies. This receiving paper may be obtained in rolls $8\frac{1}{2}$ in. $\times$ 350 ft. long, or as sheets $4\frac{1}{2} \times 6\frac{1}{2}$ in. in size.

Ticketfax has been designed to scan only very small areas and is intended primarily to produce railway tickets.

The Electronic Messenger was designed as communications equipment, but it can also be used as a duplicator. It is able to transmit to itself and produce a limited number of copies without attention. The copy received from a distant point or produced internally may be used as a master for making additional copies by duplicating methods. It is also sufficiently transparent to be used as a diazo master, or to prepare a plate for offset lithography.

The Telewriter is intended for the transmission of hand-written messages, plans or drawings to one or many points simultaneously. The receiving departments, which may be widely separated and miles apart, are notified by light or buzzer. The message is then written on the machine and is received immediately in facsimile within the other departments. Up to twenty-four receivers can be coupled to each transmitter. There is no limit to the length of the message which may be sent, and this becomes a permanent record.

Ferrography (*Ferroprint*). This process, which is still in its experimental stage, records graphic information on magnetic material, and

is then able to reproduce this on paper in visual form. The apparatus incorporates both a scanning and reproducing drum on a common shaft. By scanning the original electrically, the signals magnetize a film coated with iron oxide which is attached to the reproducing head. The matrix is then immersed in a suspension of ferro-magnetic particles, where it attracts a pattern of the original built up on a relief image in amounts corresponding to the strength and the pattern of the magnetic charge.

After rinsing, the matrix is brought into contact with a sheet of paper to produce an image of the original. To print multiple copies the matrix may be repeatedly inked and transferred. The image may later be erased and the matrix used again to record a new image.

Suitable magnetic inks have been produced in a wide range of colours, and three-colour reproductions have been made from photographic transparencies. The method of transferring the image is dependent on numerous factors, but is essentially mechanical. The image is held by magnetic attraction and is transferred by applying a dry powder to a dampened paper.

The particular use of Ferrography is to reproduce visible images which cannot be recorded by other methods. It can be useful in facsimile recording and similar systems, but it is felt by those responsible for its development that it will not supplant any existing methods but rather will find its usefulness in fields which have previously not been explored by reproduction processes.

Facsimile Telegraphy has, of course, far wider uses than those previously described. The transmission of photographic and pictorial matter by radio and land-line, although a most fascinating branch of this method, is however a highly specialized technique and is not considered suitable for discussion here.

One of the main uses for facsimile machines is that they provide an efficient teleprinter service which is economical, error free and simple to use.

Efficient intercommunication between offices within the same building or widely separated is one of the requirements of modern business, since much time may be lost by exchanging written communications. It is in these fields that facsimile communication and reproduction can be most valuable.

PART FIVE

CHAPTER XXXV

PLAN-COPYING PROCESSES

METHODS OF REPRODUCTION which are classified as plan-copying processes are able to print by contact only from a translucent original. These masters are normally engineering drawings, tracings or architects' plans which have been drawn on tracing cloth, detail paper and similar translucent materials. They can also be created by photographic means from opaque or weak originals on direct positive or other sensitive materials, or on translucent diazo foils from existing translucent originals.

The apparatus used for these methods is known as a photo-copying machine and ranges from the simple, non-continuous type to the large continuous automatic machines. The arc lamp has long been used as the method of exposing the sensitive material, but in recent years gas discharge lamps of high, medium or low pressure have been incorporated in the newest machines.

The type of machine used should be determined by the load of work it is expected to produce. Recent developments in the rotary type have resulted in large powerful machines being introduced, which are able to expose and develop at extremely high speeds in one continuous operation. Where such machines can be kept fully employed their high speed, with minimum staff requirements, provides an economy of output not previously possible.

The general purpose of the plan-copying methods is to provide copies quickly and economically, and usually of a much larger size than those produced by the other processes. Although designed chiefly for short runs, it is frequently necessary, owing to the large size of the originals used, to employ these methods for reasonably long runs, since all the alternative processes have a high initial cost and therefore require very long runs to justify their use economically.

A number of processes have previously been used for plan copying; some of them are now only infrequently employed and others have been completely superseded. The three most widely used methods in this class are:

(1) Ferro-prussiate (blue print).

(2) Dyeline (diazo).

(3) True to Scale (Ordoverax-Velography).

The silk-screen process is able to produce large-size copies and may perhaps be appropriately included as a plan copy method, although it does not use a translucent master. A brief outline of the principle of the silk-screen process is therefore given for those who may be interested, or who may desire to have copies commercially produced by this means. Reduction methods which are often used in conjunction with all these processes within the drawing office are discussed in a later chapter.

CHAPTER XXXVI

BLUEPRINT OR FERRO-PRUSSIATE PROCESS

THE BLUEPRINT PROCESS is one of the oldest and most widely known of all the plan-copying methods. It was designed to produce copies from engineers', architects' and similar drawings but has now to a great extent been replaced by the dyeline process. It is, however, still a reliable and inexpensive method, giving a copy which is able to withstand hard usage.

The original or printing master used in this process must be on a translucent material which is normally tracing cloth or linen, detail or similar paper. Copies are made by exposing the master in a photo-printing machine and in contact with a sheet of ferro-prussiate paper. It is developed by immersion in water and dried naturally or by heat. The resulting print has white lines on a blue base and therefore, although reading correctly, is reversed in tone from the original.

Intermediate masters, such as those made with sepia negative paper, can be used to create a negative from the original. When this is used as the printing master it will produce a copy having blue lines on a white base, thus enabling notes, corrections or additions to be added with greater ease. Certain chemicals may be used to intensify the blue line, thus giving a rich colour and a print of improved appearance.

A special paper producing a blueprint is also available which does not require washing or drying equipment. This material, known as Ferrazo, is exposed in the normal manner and then passed through a machine and brought into surface contact with two liquids. Development is completed at the second stage, the resulting blueprint retaining only the absorbed surface moisture and is therefore soon dry and ready for use.

Ferro-prussiate or blueprint paper has a wide latitude in exposure, and the final copy does not soil easily. For this reason it is sometimes preferred for workshop use. The paper, however, does not have exceptionally good keeping qualities before it is exposed and therefore

should not be kept in an unexposed condition over long periods. Its keeping qualities are generally considered to be in inverse ratio to the printing speed, therefore the slower the printing speed the longer the shelf life of the paper. When sealed in a polythene or similar plastic packing the paper has a reasonably long shelf life, but this will vary according to the maker and the quality of the paper.

The need to wash normal blueprint paper is perhaps a minor disadvantage. Where continuous rolls of paper can be used, washing and drying may be done automatically with little waste in time or labour.

The size of the copies produced by the blueprint process is limited only by the width of the photo-printing machine and the paper and these are generally available in sizes up to 42 in. wide, but larger machines are obtainable if required.

CHAPTER XXXVII

THE DYELINE PROCESS

THE DYELINE PROCESS has now largely superseded the familiar blueprint process and is intended to meet the same requirements by providing a copy from an engineer's drawing or tracing, plan or similar original. The print is produced on diazo paper from a translucent master which is exposed in a photo-printing machine. This paper has been more fully described in the chapter on direct positive papers.

Diazo paper is available in two well-known types, referred to generally as dry and semi-dry. The dry material is developed by exposure to ammonia gas, the semi-dry by a surface application of a liquid developer which is applied by a machine. The dry process produces prints which are reasonably free from distortion since the copy is not wetted during development, but modern, moist-developing machines do not damp the semi-dry type to an extent which causes any marked distortion, and machines of recent development, by the application of heat, deliver the prints in a perfectly dry condition. Copies from both processes can be obtained in a few seconds and handled immediately they leave the developing machine.

A wide range of diazo materials is available which vary in both speed and contrast. Papers of greater sensitivity are suitable for general work, but where more contrast is required, as in document copying, the slower (less sensitive) papers are more satisfactory. Diazo paper is the cheapest sensitive paper available which will produce a positive copy directly, and as it may be handled in daylight and will print from the large masters used in the drawing office it is particularly suitable as a plan-copying medium.

The machines used for dyeline printing are of the photo-printing type, as in the blueprint process. A developing machine is also required but in the more modern apparatus this is contained in the same machine, giving a 'combine' machine where exposure and development are automatically synchronized and continuous. A number of machines are also available which are not true combines. In these the two machines are combined, but exposure and development

is not continued automatically, the exposed print being fed by hand into the developing machine after leaving the exposing light. Both the true and the semi-combine machine reflect a wise development in apparatus manufacture.

Many machines also incorporate a revolving glass cylinder, which is a marked improvement. In the older type, the glass bend containing the light source was held stationary and the master and sensitive paper were slid around it. The glass bend, becoming hot because of the powerful arc-lights employed, had a tendency to make masters which were highly lacquered or those which had been photographically prepared adhere to the glass. The revolving glass cylinder has obviated

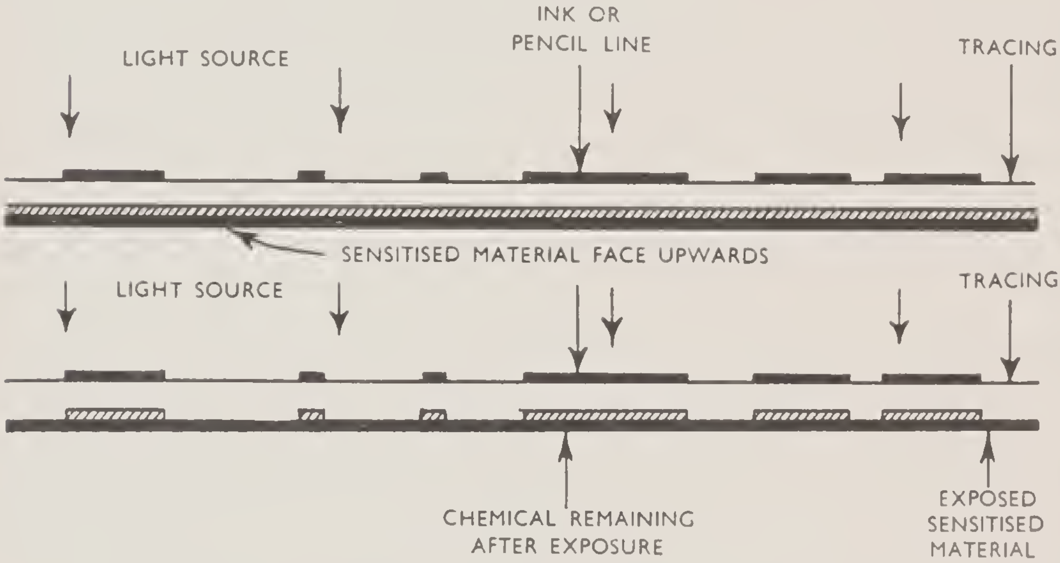


Fig. 33. *Diagrammatic sketch of chemical reaction to light.*
Permission E. N. Mason Ltd.

these difficulties, but has the minor disadvantage that marks on the cylinder are reproduced on the copy. The type and size of the machine required depends solely on the size of the work and the number of prints it is expected to produce.

Diazo materials coated on a special translucent base are also widely available. These are intended to create a new master when it is necessary to preserve the original from constant use or when additional masters are required, for example, for distribution to other departments. Some of these translucent materials are able to give an increased contrast and are therefore suitable for copying pencil or weak originals. They do not, however, give the same degree of line intensification as the silver direct positive type of material.

This transparent diazo material is exposed and developed in the normal manner with photoprinting apparatus but special developing solutions are frequently necessary.

The diazo process is a most suitable method of reproduction from large plans, drawings, or other masters on translucent material. The copies are entirely satisfactory for this purpose and when printed from a suitable original can be of a good quality. The diazo material provides a positive copy cheaply, and it can be operated in daylight with the minimum of skill. Owing to its suitability as a copying medium, it was inevitable that the usefulness of diazo paper would be extended to wider fields and applied to other processes.

CHAPTER XXXVIII

THE TRUE TO SCALE PROCESS

(ORDOVERAX-VELOGRAPHY)

THE ORDOVERAX PROCESS is essentially lithographic in principle. Originally it consisted of a gelatine composition coated on zinc plates. Modern apparatus consists of an endless band of linoleum or plastic materials, preferably whitish in colour, supported on three rollers which allow it to be moved over and under a large table. Special composition is melted, then distributed evenly over the linoleum and allowed to set.

To create the copy, a sheet of ferro-prussiate (blueprint) paper is exposed in contact with a translucent master in a photo-printing machine. This exposure to light destroys the active chemicals contained in the paper, but where these have been protected by the opaque lines of the master, they remain active. In its dry, undeveloped state the paper is then laid face downwards on the composition, pressure being evenly applied to the back of the print to give contact. It is then removed from the composition. Where the active chemicals have been in contact with the plate surface it will be receptive to ink.

A roller charged with soft printing ink is then passed lightly over the gelatine plate. The etched lines made by the active chemical in the blueprint take up the ink freely from the roller, while the composition which is unchanged by chemical action repels the ink and remains clear. Prints are made by pressing paper, card or similar material in contact with the inked surface, the ink being then transferred to create a copy of the original. For the best-quality results the image should be re-inked for every copy, but two or three impressions may be taken from each inking if required. Up to forty copies (or more under favourable conditions) may be taken from one etching, providing the conditions of working are entirely satisfactory.

The composition on the linoleum remains in a usable state for a few hours only. It is then scraped off, re-melted and, with the addition of fresh composition, made ready for re-use.

This process has been called true to scale, in the general belief that it is able to produce copies which do not differ in size from the

original. Compared with photographic copies where the paper is immersed in chemicals, washed in water and finally dried under pressure in hot machines, resulting in some stress and distortion, the true-to-scale process does give far greater scale accuracy. However, as the original tracing cloth from which the true-to-scale copies are normally produced is liable to stretch, and as varying pressure by the operator – particularly if the gelatine is too thick – can also cause distortion, a reasonable tolerance must be allowed when describing the process as true-to-scale.

This process is suitable for producing small runs of monochrome or multi-coloured copies, line or tone. The prints are of very good quality and may be produced on a high-class paper or card of any thickness or colour. They can also be made in exceptionally large sizes if required. Considerable modification of the final copy can be made by 'laying down' additional data or blocking out parts not required.

By using translucent material for the final copy, a good-quality intermediate master may be created for use with diazo and similar processes. The inked image may also be transferred to a suitable metal plate, thus creating a master for use by the lithographic process or in photo-lofting methods.

The T.T.S. process requires some skill to operate successfully, since the gelatine must be kept within certain temperatures. The composition can be purchased from a number of supply firms, or mixed in accordance with available formulae. Prints produced by this method can also be supplied by specialist houses.

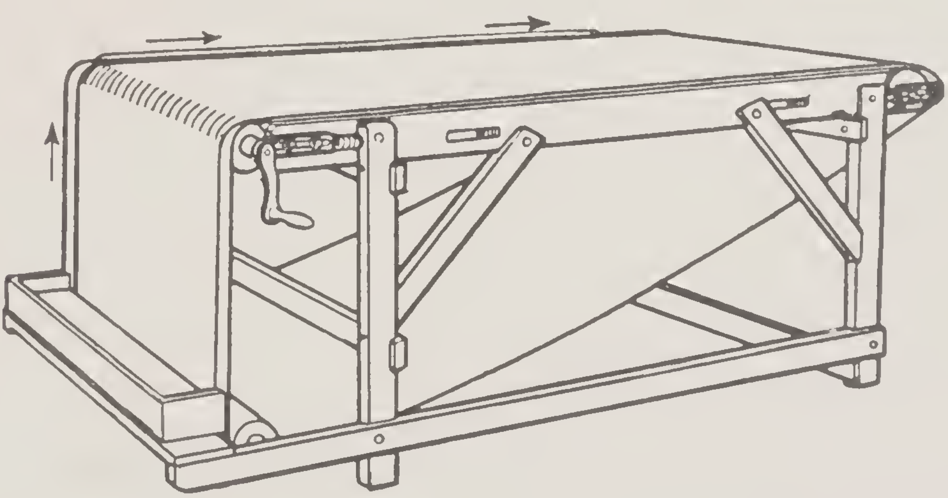


Fig. 34. True to scale. Sometimes known as ordoverax-velograph.

CHAPTER XXXIX

THE SILK SCREEN PROCESS

MODERN SCREEN PRINTING has grown from methods originally used by sign-writers, in which stencils were employed to prepare a number of copies without the need to paint each copy separately. In its original form it consisted of a cut-out stencil attached to a frame, on which fabric had been tightly stretched, allowing the stencil to be held in position whilst the paint was passed through both the mesh and the stencil to create a copy on the paper beneath it.

By slow stages both materials and apparatus have been improved and the art expanded to a method of printing which serves many purposes not possible by the more conventional printing processes. Essentially, modern screen apparatus consists of a frame over which silk bolting cloth is tightly stretched and to which the stencil is attached. Nylon gauze is also being increasingly used. Its advantages are greater strength, good colour-straining properties and easy removability from the frame, because of the smoothness of the nylon and the greater elasticity and flexibility of the tension. Its main disadvantage is that films do not adhere to this gauze as well as to silk gauze. The frame is hinged, allowing it to be brought down in contact with the base of the apparatus, on which the paper to be printed is placed. Special ink is then squeegeed manually, or by mechanical means, across the screen surface, pressing the ink through the portions not protected by the stencil and so creating a copy on the receiving paper beneath it. It will be seen that the method closely resembles that of the flat-bed stencil, differing, however, in the manner of stencil preparation and generally in the size of the copy produced.

The wide expansion of the silk-screen process during recent years has led to the development of automatic machines, which are able to produce over 1,000 prints per hour. Apparatus is also available which is able to print extremely large sizes, for poster and similar types of work.

In simple form, the stencil may be cut out of paper or cutting film.

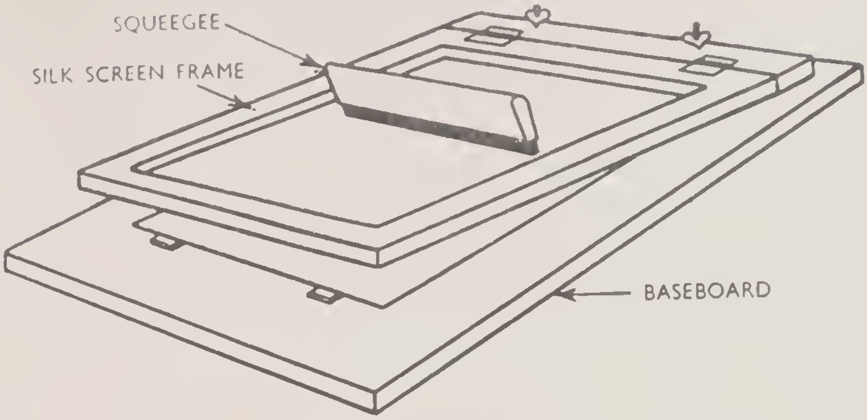


Fig. 35. Homemade silk screen press.

Specially prepared film is available which is supplied on a transparent paper backing. This is placed over the original drawing and the outline is cut to provide the master. For colour work this method will provide a series of cut-out forms, each corresponding to one of the colours to be printed. Whilst still mounted on their paper backing, these cut films are placed in position on the silk screen and pressed into the silk mesh with a warm flat-iron. The backing is then peeled away, leaving the film embedded in the silk. It can be readily seen that the film will resist the passage of the ink, allowing it to penetrate to the copy paper only where the film has been removed.

Stencils created photographically by carbon photo-stencil pigment paper are now widely employed. By their use silk-screen printing is able to produce fine line detail, delicate lettering and complicated designs. The accuracy of these stencils allows them to be used to prepare multi-colour copies and also half-tone illustrations. The Autotype Company, who have long been associated with photo stencils for silk screening, issue comprehensive literature describing how to prepare such stencils. Technicians of this company welcome the opportunity to discuss with those interested any problems which may arise.

Stencils may also be made from Kodak Ektalith film, which has been especially developed for the process. This is a photographically sensitized material which can be operated in subdued tungsten light. After exposure to a photoflood lamp it is immersed in a special activator solution, where it will develop. Finally it is transferred to the silk screen and dried for printing. By this method both line and half-tone can be combined on the same stencil and printed together. Runs of at least 10,000 impressions are obtainable from screens made by the Ektalith film. The stencil can be removed from the screen by

soaking in hot water and the silk re-used about twelve times. Explanatory literature is available for this process from Kodak Ltd.

Silk screening is able to produce prints on a wide range of materials. These extend into many spheres, including the printing of metals, glass, ceramics, fabrics, cork, cellulose acetate, celluloid and other materials. Because of its true-to-scale accuracy when using photo stencils, it can undertake work of a high degree of precision on, for example, dials for radio sets and scientific instruments.

In the wide variety of inks available are waterproof and luminous types, designed for posterizing. Half-tone effects up to an 85-line screen can also be produced, but these require the use of a half-tone screen. Stipples and other shading mediums may, however, be introduced when preparing line subjects.

It is not expected that the silk-screen method will be widely employed in reproduction work, since its applications are perhaps limited to special requirements. This brief review is included to indicate its usefulness and to acquaint readers with the principles of the process, should they desire to use the trade houses for such specialized work.

It is, however, possible to construct simple screen-printing apparatus which would enable the method to be tried, and used for special work. The illustration (Fig. 35) indicates the essential features, which include a hinged outer frame into which the frame holding the silk screen can be fitted. This is essential to allow a number of stencils to be prepared and inserted into the frame without loss of time. It is particularly useful in the case of colour runs. The base of the apparatus may consist of a table top; the hinged frame can be made to lower on to this for printing. To speed up the work, it is desirable that this should be fitted with some device for automatically raising it. A spring or weighted string passing over a pulley will serve this purpose.

The technique of screen printing contains nothing of a highly complicated nature, the principles employed being reasonably easy to master and good-quality prints can be obtained by experience. A number of centres are available for instruction, and manufacturers of materials will readily assist when requested.

CHAPTER XL

REPRODUCTION IN THE DRAWING OFFICE

METHODS OF REPRODUCTION have always been an essential part of drawing-office techniques. The use of translucent linen or paper is a long established practice, necessary to allow copies to be made from the master drawing. The familiar blueprint (ferro-prussiate) was widely used for many years and still continues to be popular, particularly in other countries. Its importance gave to our language a new term, in which 'blueprint' was used broadly to indicate 'the working copy of a master plan'.

A number of changes have been made in drawing-office practice and processes which were once extensively employed have now passed out of common use. The present widespread use of diazo paper is an indication of its usefulness in this sphere. Because of the tremendous growth in scientific and technical fields and the need for constant revision and correction, it has become customary in experimental departments to discontinue the long-accepted method of tracing. In pencil form a drawing may be more easily corrected but its low contrast makes it more difficult to obtain a really satisfactory copy. New printing masters are also often required by sub-contractors, or other departments, to enable them to produce their own copies. Further, masters become brittle and almost unprintable by hard usage, particularly in machines of the type in which the cylinder does not rotate, and old tracings become dirty and torn by handling. All these can be reclaimed by making a new master on material intended for that purpose.

The tremendous increase in the use of methods which are able to create a new intermediate master is therefore a product of this modern age. In more leisurely days there was time and staff to make hand tracings. Today the demand is for speed in production. Time is short and man-power at a premium, and the need for drawings to meet the increased production has perhaps never been so urgent. It is for this reason that the available methods of creating intermediate masters are of such importance and have become so vital

in drawing-office techniques. Tracings which have been photographically prepared have many advantages. They eliminate the time-wasting, laborious task of tracing by hand, thereby releasing staff for more important work. Also, they eliminate any checking, since photographic methods cannot introduce errors. The ability to increase line density is valuable. Such masters are generally less inflammable than ordinary paper because modern materials are on a safety base.

When making intermediate masters they may be more useful if they are direct or correct (i.e. non-reversal) copies, so that they can be read easily. In this form they are available for reference when needed and it is also easier to file them. Because such masters may have to be made with the thickness of the paper between the two surfaces there may be a slight loss of quality, but if the originals are good the effect should not be noticeable.

Where intermediates are frequently used as printing masters, they should be prepared having reversed reading. The contact of the printing surface of the master and the sensitive surface of the paper provides a print of optimum quality. With poor originals, such intermediates are almost a necessity. Corrections can be readily made on the back of these intermediates, but some form of illumination may be necessary to show the outline of the reversed side. A minor advantage of this method is that it allows all changes to be readily noted from a quick glance at the back of the intermediate master.

There are various ways of making intermediate masters. The sepia negative, or brown line print, was once widely used for this purpose. It was made direct in the photoprinting machine from a draughtsman's linen or tracing paper drawing, and was particularly useful with blueprints since it reversed the tones, giving blue lines on a white base. It was felt by those preferring this type of print that the white base enabled corrections, additions or notes to be added to the print.

The direct positive type of paper (discussed in Chapter X) was originally introduced to prepare an intermediate master from pencil or other drawings. As it can be exposed in the normal photoprinting machines, and gives extreme contrast, it is particularly suitable. Where large reflex boxes have been employed as reflex printers, the substitution of photoflood lamps for the normal ones previously fitted will enable this paper to be used. If it is required to continue the use of reflex paper, the lights may be connected for series-parallel operation by a special switch, which will enable the lights to be

burned at either reduced or full voltage, thereby giving controlled exposures on both materials.

Special linens and other translucent materials coated with diazo are also available for making new masters. These are exposed in the normal diazo printing machines, but some require special developers. An examination made of the diazo intermediate master foils indicated that not all of the wide range obtainable are able to produce a copy which has a line of greater density than the original. This somewhat limits their use where pencil masters only are available.

The True to Scale process has also long been used for making intermediate drawing masters. This method produces an ink line of great density and it is therefore able to make a master of very good printing quality. In addition, by this method parts of the original may be removed or new ones added, as required.

To give the greatest possible density when making the original drawing a special yellow carbon paper, known as Traceron, has been introduced. A sheet of this carbon is placed upwards on the drawing board with a sheet of detail or other translucent paper over it. A drawing made in the usual way will be repeated in yellow carbon on the reverse side of the paper. No special care is needed and almost any type of paper or pencil may be used. It will be appreciated that the yellow carbon deposited behind the pencil line will create an opaque barrier to the printing light used in the photoprinting machine; also, it will allow the master to be passed through the copier at a much higher speed and give a dyeline of good density, with no background deposit. The yellow carbon does not transfer to other drawings, but it has the disadvantage that corrections must also be made on the reverse carbon side.

THE RAPIDOGRAPH PEN

The Rapidograph is a new pen especially designed for use in the drawing office, and for this reason is being widely used with the new translucent techniques. The particular feature of this pen is that it is able to use a dense black ink, of the Indian ink type, without clogging and, owing to its design, it will deposit a line of the same density, irrespective of the pressure applied to it. By this means it avoids one of the difficulties experienced in all drawing offices, where lines of varying thickness are created because of the different pressures applied and by the use of other pens which require frequent refilling.

A short test made with this pen indicated that it increased output by about 50 per cent because, when once charged with ink, the pen

can be used for a considerable period. It is filled by unscrewing the top, inserting the ink and re-screwing, an operation which can be completed in a few seconds.

For use with translucent masters which are subsequently to be produced by the dyeline process, the pen is ideal. The ink used has complete ultra-violet opacity and is therefore able to produce results of a high quality.

The Rapidograph pen is obtainable with interchangeable heads to give lines of varying thicknesses.

Recently, other methods have been used for a number of applications in industrial drawing offices and, with the development of a new processing technique in the U.S.A., it is possible to produce diagrams, layouts and other drawings on glass fabric materials. These are able to give improved reproduction qualities.

The new process consists of an opaque coating which is applied to the surface of the glass fabric material to enable line, numerals, letters, etc., to be scribed or cut into the surface of the material. The coating does not crack or peel, even under extreme handling, and if it becomes smudged or dirty it can be cleaned with soap and water, without damage to the material. Mistakes are easily corrected by applying the coating material with a small brush.

An advantage claimed for this method is that, irrespective of the pressure applied to the steel-tipped stylus, there is no appreciable difference in the thickness of the line—also, the stylus point remains sharp indefinitely.

The cost of the glass fabric material is more expensive than that of detail paper, but it is almost indestructible. Also, it has the disadvantage that if used normally it will give a copy which is reversed in tone.

REDUCING CAMERAS

Reducing cameras are also used to produce new intermediates of improved quality. The 70 mm. and half-plate film is able to give a contrasty negative which, when enlarged on suitable material and developed by contrasty developers, will produce a good printing master, or give positive copies on opaque paper if required. The advantage of this method is that both the new master or the copy may be of the same size, or larger or smaller than the original. It is frequently convenient to have a copy made large for workshop use, or about half-size for reference in the office.

These reducing cameras are also widely used to reduce space. For keeping a record of old and little used drawings the system has

much in its favour. In addition to making printing masters or opaque copies, these negatives can be enlarged for examination visually in an optical viewer. A contact print or small enlargement of the negative inserted in a card index file is useful for visual inspection.

PHOTOPRINTING MACHINES

The type of machine used for photoprinting is of some importance. Many of these have been so strongly built that they have outlived their usefulness. Slow in speed and requiring separate developing apparatus, they have become uneconomical in these days of high labour costs. If a number of these machines are still employed it may well prove economical to replace them with modern apparatus, which is able to work at greater speed and with reduced staff.

The type of photoprinting machine required will depend chiefly upon the output expected from it. In reorganizing a section having a number of machines two alternatives are possible. All these machines may be replaced by one large machine which is able to print at very high speeds. Machines of this nature may require a large staff to operate them efficiently. Those feeding the machine must, on account of its speed, feed it continuously with masters to avoid wastage, particularly when working on continuous rolls. Other staff must also provide the operators with a constant supply of masters. Such machines are undoubtedly economic when they are kept fully employed. The disadvantage of this type of apparatus is that spare staff must be available for sickness and other causes, and breakdowns can be really serious because the output of the section is at zero during that period.

From a careful observation of this factor, it would appear that there are advantages to be gained from using machines of the combine or semi-combine type, which require only one operator. These machines are generally able to produce the maximum output obtainable by one person, and have the advantage that when breakdowns occur, or operators are absent, only one part of the output of that section is disturbed.

CONTINUOUS ROLLS OR CUT SHEETS

Paper is obtainable for photoprinting in rolls of any width and sheets of any size, within the limitations of the apparatus concerned. Over a long period, the use of paper in roll form has been universal. In recent years, cut sheets have become popular and their use is increasing yearly.

There have been many arguments to prove that cut sheets are not economical. These have normally been made by makers of extremely large machines, which work at tremendous speed and with paper exposed and developed in one continuous operation. However, few machines in this country are designed to work at such speed and with so large a staff. Normal apparatus is intended generally to be operated by one person, and if the machine is working at a few feet per minute only, then cutting from the roll does not waste any time. It may be said that large cut sheets are difficult to handle. As with all arguments of this kind, much depends on the machine being used and on the operator's method of working. If a reasonably large number of copies are required from two or more masters, and the operator can feed them through the machine without cutting the paper, then undoubtedly paper in roll form is economical. However, the widespread practice of cutting from the roll may eventually be discontinued when using masters not larger than about 20 × 30 in. in size, because of the advantages given by cut sheets. It is for this reason that cut sheets have been so widely adopted in document copying, where generally only small sizes are used.

TRIMMING

Many methods of trimming large prints are practised in various departments. It would appear that any of these, worked with the speed normally acquired by long experience in the work, would be efficient.

One method, which has been found to be satisfactory, is to pass a pin through the copies at a given point on each print, until the pin can take no further copies. This is repeated at the diagonal corner, the copies then being trimmed as a single sheet, with the hand trimmer or guillotine. Since most drawings have a line surround this provides a common point, at the juncture of the two lines, through which to pass the pin. This task can be done while the operator is seated and is therefore less tiring than trimming each copy separately.

PART SIX

CHAPTER XLI

MICROFILM

The terminology used in this chapter is under discussion by The International Organization for Standardization (I.S.O.). It is possible that by international agreement it may be changed. It should be noted that microsheet is often called Microfiche, but in Holland it is somewhat confusingly called Microcard although it is transparent

MICROFILMING is the name given to a method of producing photographic images of documents on a reduced size, in which form they are unreadable by the naked eye. They are normally produced on roll film 16 mm. or 35 mm. in width, and are also available on 70 mm. roll film, sheet film and opaque card. Both the transparent and the opaque sheets are available in a number of sizes, the more usual size being 7·5 × 12·5 cm. The transparent form is called a Microsheet and the opaque medium is registered as 'Microcard'. Other sizes of opaque material are also used, one of which is 6 × 9 in. containing 100 micro reductions, is printed by lithography and is called Microprint.

The flat techniques are not intended to compete with, or to supersede, the micro-roll but are designed to meet requirements for which roll microfilm is not entirely suitable. They therefore extend the usefulness of microfilm into wider fields.

In all these forms the images are visually inspected in an enlarged size by the use of a specially designed viewer, reader or projector. They may also be photographically enlarged, either automatically or manually, to produce duplicated copies of the original.

In roll form 100 ft. of 16 mm. film (approximately 14 cubic in.) may record 6,000 to 24,000 small documents or 2,000 to 8,000 normal letters, depending on the type of document and reduction ratio used. The stand type of camera using 35 mm. film contains 1,600 half-frames or 800 full frames. A full frame frequently includes two or more pages of material.

Cameras designed for the microfilm process are of two types. (1) automatic continuous, (2) stand or copy board. The continuous type is designed to take single documents of any length but of a limited width up to approximately 11 in. The documents are fed into the camera by hand or by automatic means.

In its passage through the camera, the document is photographed as it passes an illuminated slit, both film and document being in motion during the exposure.

Microfilm cameras in this country utilizing 16 mm. film are usually of the high-speed continuous type, an exception being the Desk Model Recordak which is of the repeat type and which will take documents up to 12 × 14 in. Whilst the normal model produces document images in sequence occupying the whole width of the film, other models use the duo system, where only half the width of the film is exposed at one time. The reduced images are contained on one side of the film in sequence, and by reversing the roll in the camera after the first half has been exposed more images are then produced on the other side, also in sequence. The duplex system photographs simultaneously by the aid of a mirror system both the back and front of a document, thus producing the two images side by side across the width of the film. The speed of the continuous type of machine is extremely high, particularly when automatic feeds are used. The bulk use of 16 mm. microfilm is in connection with commercial systems, when its employment often enables substantial savings to be made. These are too varied, and often too complicated, to describe here.

The stand type of camera usually consists of a baseboard with an upright column on which the camera is fixed. It is able to photograph on 35 mm. film, from large or small documents and also from books varying in thickness. In operation, the document to be photographed is placed on the baseboard or holder and the camera set to the required height. A foot switch is normally provided which, when depressed, will make the exposure and automatically move the exposed film, leaving the camera set for the next exposure. This type of camera cannot compete in speed of operation with the continuous type but should be expected to provide an average of approximately 2,000 exposures per day, except where the operator is required to collect, sort and dispatch the documents being copied.

Some confusion frequently arises as to which type of camera should be used for a microfilm project. The question is frequently simplified by remembering that in this country the continuous type is limited to single documents up to approximately 11 in. wide on 16 mm. film. Where documents are only available in book form or are larger than 11 in. wide, it is necessary to use the stand type of camera, unless apparatus of a foreign make is available.

Microfilm is used for a wide range of applications, of which, perhaps, the most obvious is that of saving space and weight. In roll form it is frequently used as a security against damage to the

originals and for preservation. More recently, it has been increasingly used against fraud. It is also useful for the dissemination of data, scientific abstracts, books, periodicals, particularly for sending abroad, the reduced film minimizing the bulk in overseas mails.

The process is particularly suitable for providing in a cheap, reduced and permanent form documents which are otherwise inaccessible. Documents on paper with poor keeping qualities, e.g. newspapers, are frequently microfilmed to preserve a record in a greatly reduced form. One useful advantage of the roll type is that automatic apparatus is available for enlarging the film on to paper, thus creating a positive copy of the original at a minimum cost. Means of enlarging the Microsheet to produce paper copies are also available, but not, as yet, in automatic form in this country.

Much confusion regarding the keeping qualities of microfilm has frequently arisen, but it is estimated on the best authority that the new acetate base, if adequately processed and rendered free of hypo, will outlive all normal types of paper when kept under proper conditions of storage. Many of the misconceptions regarding this factor are due to the previous use of nitrate film, particularly for cinematograph work. This film has a tendency to shrink and grow very brittle with age. These changes were accelerated by projection with a powerful light, emitting considerable heat, and by being passed, at extreme speed, through machines of inferior design. Sprocket shrinkage is of no importance with microfilm, in fact much of it is now manufactured without sprockets, furthermore, with modern film, stored under reasonable conditions, these previous weaknesses no longer apply.

The newer techniques, both Microsheet and particularly Microcard, can be considered as a means for limited publication of both books and other literature now out of stock, or for articles from educational booklets and scientific journals. Micro techniques are normally not designed for continuous reading but for examination, study and reference. The ease of filing, indexing and ready reference and the reduced space required by the flat techniques offset to a large degree the disadvantage of having to use a reading machine. Filing systems are also available, which, by making paper copies from roll film and attaching these to a card, create a result which can be used in the same manner as a Microcard. The particular feature of this method is that existing microfilm in roll form may be utilized to build up a filing system on opaque cards. The method is also particularly suitable for a cumulative filing system, because any size of card may be used and the small opaque copies can be added as they are made.

The Visigraph method uses 16 mm. film, from which small contact copies on photographic paper are made. The filing card is coated with an adhesive, having a protective layer which, when removed, allows the opaque copy to be placed in position on the card. The size of the card is 6 × 4 in., having an area of about 4 × 4 in. to which the opaque prints may be attached.

It is claimed for this system that the contents of twenty file drawers can be contained in a small Visirecord filing unit, which is smaller than the ordinary file drawer.

Similar in design and purpose is Microstrip, which is also intended as a method of filing micro images separately, indexed by subject and using ordinary file cards of any size. In this system the opaque paper prints are made from 16 mm. films and are coated on the back with a plastic adhesive. The strips are cut and then moistened like a stamp, and pressed into position on the card.

In both these systems, an opaque microcard reader is necessary to view the images and the original 16 mm. film is used when separate enlarged copies are required.

Other developments in microfilm techniques are being more widely adopted. Methods of inserting one or more frames of microfilm into cards of many sizes and shapes, including the familiar punched card, are now in constant use. This technique enables particular frames to be readily sorted and adds considerable information to the data already contained on the punched card. High-speed selectors and electronic devices are now using coded microfilm to produce information at astounding speeds.

Where information is cumulative, microfilm can be inserted in special acetate containers, the additional microfilm frames being added as required. Methods of this nature are particularly useful for hospital case records and similar applications. The two methods previously described of creating opaque cards from printed copies of roll film are also useful for this purpose.

The Kard-A-Film method consists of a long narrow card container into which lengths of 16 or 35 mm. film may be inserted. These cards enable information to be added or subtracted in correct group sequence, and therefore, although reducing storage space, allow the flexibility of the average filing system. Reading apparatus to accommodate these cards is available for both sizes of film and these can be converted to use roll film if required. The standard size of the 16 mm. card holders is 5 × 3 in. and 6 × 4 in. holding eighteen to twenty-seven exposures – the holders for 35 mm. film are 8 × 5 in. and 8 × 10 in. containing ten to twenty exposures. Special sizes are also available.

Microfilm is also used as a normal means of document copying. By the use of automatic continuous enlarging and processing equipment, it provides a cheap method of reproduction. It can, however, be used economically for this purpose only where large demands allow the use of this bulky and costly equipment. For this reason, its use is restricted to large establishments where a considerable amount of work is done. Machines which permit both Xerography and Electrofax to produce continuous rolls of copies from roll microfilm will do much to extend this method where the amount of work can justify such apparatus.

The use of microfilm as a means of document copying where manual methods of film development and enlarging are necessary, considerably increases the cost per copy, and is uneconomical in comparison with other reproduction methods. Although widely used on the Continent where the method is considered to be economical, a careful cost examination made in this country has indicated that it is only cheaper than other methods of document copying when the continuous type of apparatus is used throughout. It is also less convenient because the exposure of the film and its subsequent development considerably delays the production of the final copies. It has, however, the advantage of providing a positive copy and allowing the negative to be stored in a minimum space.

COSTS

The numerous variable factors which have to be considered in estimating both the cost and space reduction of microfilm make it impossible to give accurate figures for all conditions. The following considerations are therefore offered only as a rough guide to assist those who may desire to estimate these factors.

The cost of producing 16 mm. film would depend on the number of documents contained on one film and the speed at which the documents could be fed into the exposing machine. Other factors would also have to be considered, which could only be estimated after a careful examination of the documents concerned.

The retail cost of the Recordak 16 mm. film, including processing, is 20s. per 100 ft. A film of this size could contain from 1,500 to 6,000 documents not larger than 13 × 8 in. and, hand fed, 1,500 sides of documents may reasonably be filmed in approximately one hour.

The size of one 16 mm. film of 100 ft. (processed film is returned in lengths of 100 ft.) contained in a metal reel and fitted into the cardboard box is $3\frac{3}{4} \times 3\frac{3}{4} \times 1$ in., or approximately 14 cu. in. for a minimum of 1,500 sides of documents. It has been estimated that

one linear foot of shelving of such documents would contain approximately 2,000 papers. The space reduction given by microfilm would depend on the reduction used and whether these were single- or double-sided documents, i.e. what percentage of them would require two exposures.

The price of 35 mm. film is 48s. per 100 ft. including processing. This film, recording 800 or 1,600 pages, is contained on a reel within a cardboard box, $4\frac{1}{4} \times 4\frac{1}{4} \times 1\frac{3}{4}$ in. Assuming one linear foot of normal documents at 2,000 and 1,600 pages per reel, this would require for double-sided documents $2\frac{1}{2}$ reels or 79 cu. in. which is approximately 1/26th of the original space required.

The above factors are given only as a rough guide, since shelving space for microfilm and other items of cost will be involved. It may, however, assist in giving an indication of the probable cost and space reduction before making a more detailed analysis.

When difficulty is experienced in determining the size of the film to be used, preliminary tests should be made from a fair sample of the documents to be copied and on both sizes of film. The results should be carefully examined for clarity. It cannot be too strongly emphasized that the common practice of using extreme reductions should be avoided, unless the films are required only for scrutiny. Where microfilm must be read, particularly over long periods, it is essential that the reduced images are readable without undue strain. Considerable harm has been done to this process by over-reducing the image. This may provide a penny-wise economy, but if the film is not acceptable the cost of producing it is a waste of money.

It is always essential that those who use the film for obtaining such information as it contains should at all times find it acceptable, otherwise the resentment towards the process will always continue. For this reason, the practice of including a statement indicating that 'the following frame or frames are taken from poor originals' is a commendable one. This prevents unwarranted criticism of the microfilm process.

It is also desirable that before commencing to film the actual documents a test chart should be exposed on the first few frames. When the film is processed these frames will indicate whether the focusing exposure and development were correct.

Objections to the microfilming of documents, some of which are in frequent use, could be obviated by filming only documents which are infrequently used, thus allowing the live documents to be handled in the normal manner. Filed documents, particularly those to which new ones are added daily, are in constant use for relatively short periods. It is a simple matter to assess this 'live'

period and film those to which only occasional further reference must be made.

Most of the disadvantages associated with the use of microfilm, particularly in roll form, can be avoided by filming the documents in a manner in which they can readily be found. Careful indexing, by the introduction of cards or other signals which break the film into well-defined sequences, will do much to enable the selection of a particular item to be made without difficulty.

The key to this indexing should be written on the cover of the cardboard box in which the film is stored. This will help the searcher to see where the required information is located on the film and enable selection to be made speedily. Records on microfilm which have been carefully filmed with these precautions can often be found more easily than the original file document.

For use with all forms of microfilm, a wide variety of viewing or reading apparatus is available. These vary in size, type and design, and are read by projection on to a transparent screen or opaque base. All have their advantages and the choice is one of individual preference.

INTEGRATED MICROGRAPHIC SYSTEM

This method of recording is designed to reduce documents from sizes up to 28 $\times$ 36 in. on to either 35 or 70 mm. film and to re-enlarge them to create copies or intermediate printing masters. All the machines designed for this method are completely automatic, giving extremely high outputs with the minimum of staff.

Designed to give extreme reduction and yet preserve fine detail, the original purpose of this system was to supply small film packages arranged according to content, which could be reproduced in quantity 'in the field'. Although originally intended for use in the U.S. Navy, it was felt that it could be used to meet a similar purpose in other Service Departments or in industry and has therefore been made available for more general use.

Known as the Integrated Micrographic System, it combines the functions of a semi-automatic copying camera, a printer and a viewer. The camera accommodates up to 100 ft. of 35 or 70 mm. film. An automatic processor is available for developing the negative material. When the film leaves the drier it is threaded, endless belt fashion, to the spools of the duplicator. This device produces either negative or positive transparencies for dispatch to other fields of operation. After reaching its ultimate destination, this material is enlarged to provide a printing master for duplication by diazo or other methods.

The main advantages claimed for this system, as in all reduction methods are that it saves storage space and can be transported by air at reduced cost and with minimum time delay.

The camera is able to take either monochrome or colour film. It is automatic, reducing continuously within the range of five to fifteen times on 70 mm. film and ten to thirty times on 35 mm. film.

A unique feature of this apparatus is the double-sided rotatable vacuum easel which allows the reverse side to be loaded whilst the other side is being copied.

The enlarger enables negatives to be enlarged back to the original size and a viewing easel is available when an opaque copy is not essential.

The processing apparatus is able to take either 16, 35 or 70 mm. film. It is temperature controlled and completes the operation in approximately half an hour for monochrome film and one hour for colour film. No dark-room is required and since it is thermostatically controlled it can be operated by unskilled labour.

The price of the commercial apparatus is not yet known. It is expected to be fairly high, but it is claimed that since no specialized skills are required and since it is able to operate at high automatic speeds with a minimum of staff requirements, it will enable reproductions of good quality to be made economically.

COLOUR MICROPHOTOGRAPHY

The wide variety of excellent colour films obtainable in both 16 and 35 mm. sizes, together with the processing facilities available, enable microfilms to be made in colour with the minimum of technical skill. The supply of small paper colour prints by the film manufacturers has also extended the possible scope, but the cost of both colour films and prints imposes a severe restriction on the wider use of these materials.

It is important when using colour film for the lights to be of the correct type and burned at the rated voltage. The quality of the processed film is considerably influenced by what is termed colour temperature, i.e. the colour of the light source used. This can be measured by meters available for the purpose, but careful attention to certain details may make their use not essential in this somewhat restricted field. Lamps that are run on voltages other than those for which they were designed will emit a different colour of light. It is therefore desirable to have some form of voltage control. Also, lamps that are burned well beyond their stated life may produce degraded results.

It is also necessary to see that the lamps are placed so that they do not cause reflections and that all are burning at the same brilliance. Reflectors should be of a matt metal finish or, if painted white, they should not be discoloured.

Not all lenses are corrected for colour photography. Special tests are sometimes recommended by the manufacturers of colour material, but for normal work a practical test will indicate whether the lens is satisfactory for the purpose.

Transparencies that are required for reproduction, either as colour prints or by the printing processes, should be slightly underexposed in comparison with those required for projection.

CHAPTER XLII

LARGER MICROFILM

WHEN ANY DOCUMENT is considered too large or of insufficient quality to be reduced on 35 mm. microfilm, it can be recorded by apparatus which uses a larger size of negative material. This apparatus consists essentially of a large, horizontal camera, suspended on rails for ease of movement, and having a copy-holder and a light source. The size of the film normally used for this purpose is half-plate ($6\frac{1}{2} \times 4\frac{3}{4}$ in.), in cut sheet or roll form. In some countries roll film of 105 mm. width is also being used. These machines are able to make a reduced negative from the original, and if necessary to enlarge this negative on to sensitive paper, or other sensitive material, to any size required within the limits of the machine, usually 60×40 in.

Normally, these film negatives are filed individually in separate envelopes and stored in steel fireproof filing cabinets designed for this purpose. This method allows ease of filing, indexing and a quick replacement of superseded drawings.

Reading apparatus is also available for the visual examination of film produced by this equipment.

Apparatus of the microfilm type which records on 70 mm. film, giving an area four times greater than 35 mm. film, has now been introduced in a number of countries. Because of its many advantages (it would appear to be a logical development from 35 mm.) it is gaining popularity. The normal design of the 70 mm. camera is similar to the stand-type microfilm apparatus, the column being longer to allow the necessary extension required by the greater focal length lens used in this apparatus. The horizontal type of camera taking 70 mm. film is also available. Film of this size can be filed in rolls or in single sheets, and therefore have the same storage convenience as both 35 mm. and half-plate films. In some countries, apparatus has been designed which will automatically make enlargements from 70 mm. film, both roll and single-sheet negatives. The normal photographic enlarger, taking negatives not less than 3×2 in., is also suitable for making enlargements from this size of film.

The larger microfilm, both 70 mm. and half-plate size, is designed to meet the same general purpose as the smaller film. The negative is effective for current use by visual reference or subsequent reproduction, or for archival purposes. It can therefore be considered as an extension of the 35 mm. negative methods, able to copy material which is too large, or of a quality not suitable for reduction to the smaller negative sizes. Its main use is to create a record in reduced form from engineers' drawings, tracings, plans and similar material which is infrequently used but cannot be destroyed without a record being made available. The process is particularly suitable for this purpose, since the negatives created can be viewed in enlarged form by projection or, by photographic methods, used to create an opaque copy or translucent master for subsequent printing on diazo paper.

This method is also useful for copying pencil drawings or weak originals and providing a photographic copy having an increased contrast. The photographic materials, both film and paper, used in this process enable an increase in the density of line to be made at each stage. By copying the pencil drawing on to the high-contrast film and enlarging this on to positive material, translucent or opaque, a copy is produced with a line density equal to that of an ink tracing. A translucent master made by this method would also give improved copies by the blueprint or diazo processes.

The horizontal apparatus designed for the half-plate film is generally able also to accommodate larger-size films, and, in some, half-tone screen gear may be fitted if required. The equipment is then essentially a process camera, able to do normal copying work from a wide variety of originals, and is limited only by the size of the negative it can produce, or the copy which may be accommodated in the copy-holder.

The purpose of all reduction processes is to obtain a high degree of quality in recording and, therefore, to provide a negative of a size large enough to give an enlargement to the required size without loss of quality in the print. The use of this specialized apparatus enables this purpose to be achieved with the minimum of expense and skill.

The two well-known machines for this work are the Barcro and Statfile sold by E. N. Mason and Recordak respectively.

CHAPTER XLIII

REDUCTION CAMERAS

THE KODAK LISTOMATIC CAMERA

BASICALLY this is a camera designed to photograph at high speed in columnar form one, two or three lines of type from punched cards. It produces this information on a film negative which can be quickly reproduced by photolithography. By this means it brings a high degree of automation to the mechanical preparation of type listings for publications such as directories, catalogues, price and part lists and similar material.

In use, the cards are fed into the camera, which will automatically photograph the typed information at a rate up to about 700 lines per minute. It is able to record at the same size or in varying degrees down to half-size from an area on the card up to $6\frac{7}{8} \times \frac{1}{2}$ in. Other adjustments allow the listing to be composed at from six to fourteen lines per inch.

The film is supplied in rolls of 400 ft. length, ranging in widths from 2 to 8 in. After processing, it is cut into column lengths to provide a negative which may be printed by photolithography or used to provide the result by any of the recognized methods of reproduction.

The quality of the work produced is extremely good and the system is particularly suitable for compiling catalogues and directories, since it is able to save time by the elimination of type-setting.

PEERLESS NEOFLOW

Reduction cameras which use sensitive paper are also available in some countries. One of these, the Peerless Neoflow, has recently been redesigned to provide an apparatus which is quickly and easily focused and able to give reductions on a wide variety of materials.

The basic principle of this machine is that it reduces copies at reductions of 2 : 1 up to 6 : 1, using the continuous-flow principle. Any type of original of any length and up to 42 in. width can be accommodated. These originals may be engineering drawings,

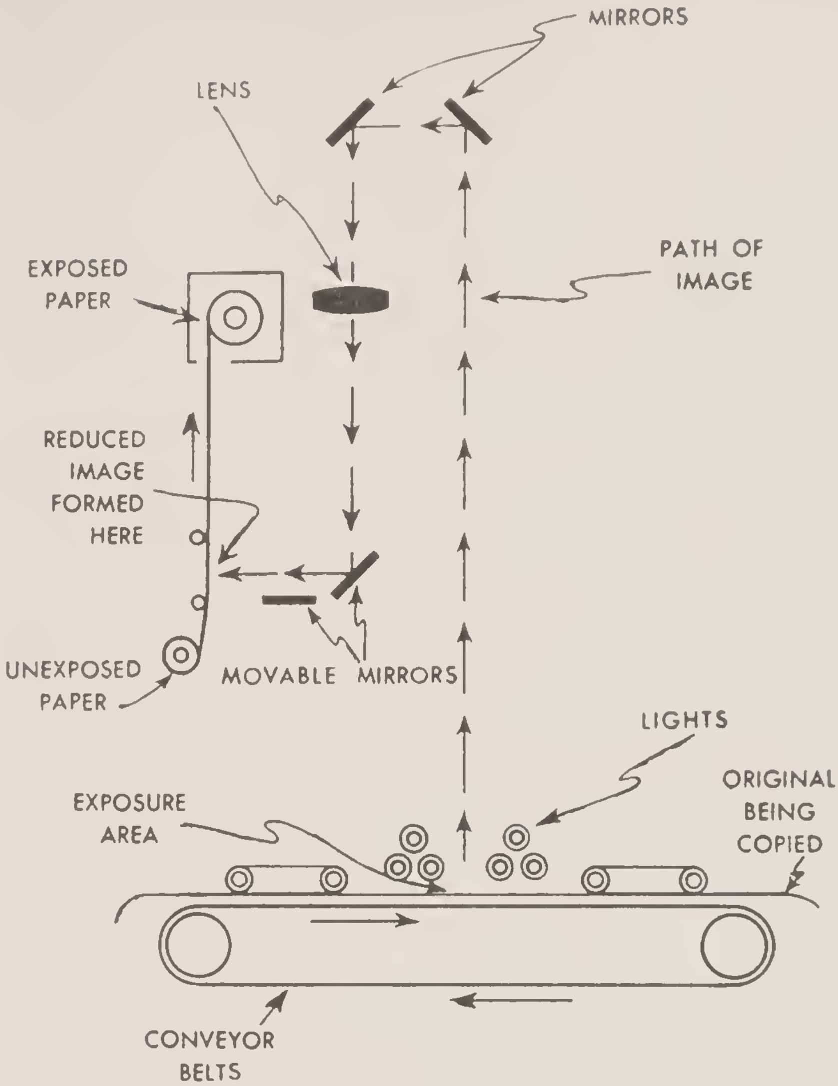


Fig. 36. Peerless Neoflow reducing camera.

prints or any matter, typed or drawn. The reduced copies may be made on any type of sensitized material. The copy produced is negative in tone but may be either right reading or reversed (mirror) reading, as desired.

This apparatus makes the reduction by using a series of mirrors and a single lens. The attached diagram will illustrate the method adopted. A number of models are available, all of which can be operated in daylight. A separate, continuous processing unit, which is also able to operate in daylight, is used to develop the rolls of exposed sensitive material.

The principal use of this type of equipment is that it is able to reduce drawings of up to 20 ft. in length to a size which is convenient to handle, and can be reproduced more cheaply in the diazo printing machine.

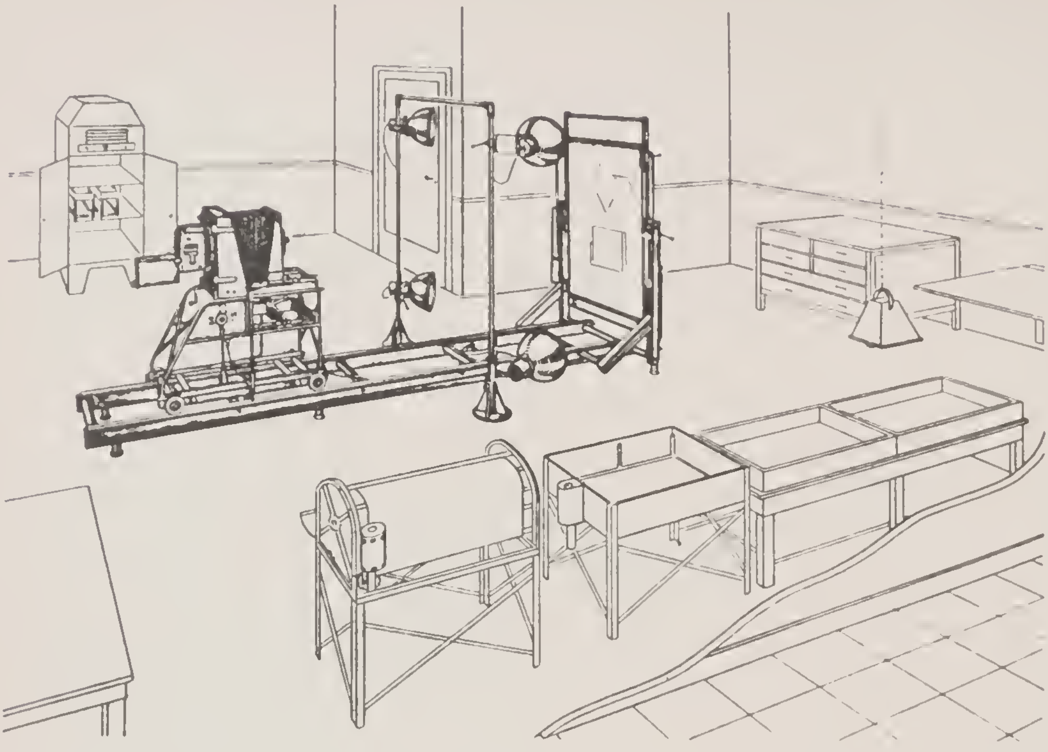


Fig. 37. Showing the suggested layout by Photostat Ltd. for use with their Statfile apparatus. The small room is intended for processing the negatives. The processing trays for making prints are shown in the foreground.

CHAPTER XLIV

MICROFILM RAPID SELECTORS

THE EXTENDED RANGE of human knowledge has called for machines able to assemble and disseminate scientific data at high speed. The development of rapid selectors is intended to meet this requirement. These systems provide for the storage of abstracts and other data in microfilm form which is specially coded, allowing speedy selection in a number of different fields. Thus it is possible to group and classify knowledge according to the need, to reassemble the information as and when required, and to recopy this information by high-speed photography.

The Bush Rapid Selector was one of the earliest machines of this type. The apparatus is large and expensive, having an array of electronic selectors, switches and high-speed mechanism. Selection is made by passing the film rapidly across a beam of light, which is directed on an 'electric eye' or photo-cell. Variations in light intensity, caused by coded marking on the film, produce variations in electric current through the cell. The machine can be set to recognize a particular pattern of currents coded to identify a chosen subject, and will stop the microfilm frame sufficiently long enough to produce an enlarged print by producing a spark flash through auxiliary apparatus.

A further high-speed microfilm selector has been designed in France by Dr. Jacques Samain. This machine, known as Filmorex, uses microfilm in sheet form measuring 72 × 45 mm. The right-hand side of the sheet contains two pages of text and the left-hand side has the code which enables electronic selection to be made. A special camera using 70 mm. film is available for producing these micro-sheets. More recently this selector has been designed to take 35 mm. film

These small films can be stored in filing cabinets without any classification and information can be extracted at the rate of 600 sheets per minute. The selected micro-sheet is automatically ejected when the pre-selected codes correspond with each other. No method of reproduction is incorporated in these machines, but selected

sheets can be read in a microfilm viewer or enlarged by normal photographic means.

The Kodak Minicard is a small piece of film containing digital information and micro-images, therefore combining both the desirable characteristics of the punched card and microfilm systems. The card consists of a small piece of photographic film 16 × 32 mm. A slot at one end enables the card to be handled by means of a metal stick at speeds up to 1,800 cards per minute. It can carry up to twelve micro-images or digital information up to seventy columns. The cost compares favourably with both punched card and microfilm and it is claimed to have many advantages. The Kodak Minicard and the Minicard selectors are designed to handle all the requirements of information systems.

The Telemeter is another system of information storage which makes use of extreme reductions on high-resolution emulsions. The storage densities are said to be over 10^8 bits per sq. in. and selection in the order of 50 milliseconds to any word in a 20 million bit store. Compared with punched cards which provide about 3,000 bits per cubic in., and also reading at speeds of approximately 3,000 bits per second, it will be seen that the Telemeter provides a far more compact medium with a very much faster reading rate.

The method is designed as a photoscopic information storage unit able to provide a wide range of information at very high speeds. The development of extremely fine-grain emulsions has enabled storage to be made at a density of a million bits per square millimetre thus enabling a plate 3 × 5 in. to have a storage capacity of the human mind (10^{10} bits) or on plates occupying less than a cubic yard to contain all the information stored in the Library of Congress (10^{14} bits). These extreme reductions, however, permit both the handling and the searching of the medium to be done with a simple and compact device.

The Photoscopic Storage Unit may vary in design according to its specific application – normally it consists of a glass translucent disc, 16 in. diameter, on which the information has been recorded photographically in concentric tracks, and in either wholly or partially digitally coded form. The information is read by a beam of light shining through the information tracks as the disc revolves. The light passing through the disc is converted to electrical signals.

A disc can store 20 million bits, equivalent to 4 million characters or nearly a million words. At a nominal speed of 2,400 r.p.m. information can be read at the rate of one million bits per second. The maximum access time to any chosen item is the time of one revolution or 25 milliseconds. By the use of several reading heads

this time can be considerably reduced, the basic cost of each unit being so low that several could be economically used to meet most scientific commercial requirements.

It is claimed for all these rapid selectors that, considering their many advantages, their cost is relatively small. This brief review of these techniques is included because of their close association with the microfilm process, and to indicate the widening horizons possible with this flexible medium.

PART SEVEN

CHAPTER XLV

COMPARATIVE COSTS IN REPRODUCTION METHODS

ANY METHOD which endeavours to give a general estimate of the costs of the reproduction processes can only indicate their relative economic ratio. The many variables which must be considered make it impossible by a general examination to indicate the actual cost per copy when operational conditions differ so widely.

The following charts therefore give only the relative cost of these processes. The actual cost of these methods can only be obtained by an examination of the work concerned, taking into account all the relevant factors, and from this information estimating the production costs of the processes employed. The points which will need consideration are the wages of the staff employed, the materials consumed, overheads and machine depreciation. It will be readily appreciated that the final figure will depend largely on the skill of the operator and the output produced from the machine.

The figures given in the following charts were obtained from an examination made of all the available reproduction methods to determine their relative costs. The examination was based on material and labour costs only and did not include either overheads or machine depreciation. The figures given may therefore be considered by some to favour processes which require expensive apparatus or those necessitating costly overheads. However, the cost of a machine over its normal life span of ten or more years does not considerably alter the relative reproduction costs, particularly since the more expensive machine can usually produce a greater output for the same labour costs. Also overheads, being indeterminate factors which vary widely by the geographical location of the department, cannot be assessed in an examination designed to produce only relative costs. Any additional allowance for this would disturb the balance for those whose overheads may differ from the allowed figure. It is general practice when estimating costs to allow a fixed rate for this factor. Those therefore who wish to include overheads can readily add an agreed percentage to the figures given in the charts.

PROCESS	TYPE OF MASTER	METHOD OF MAKING THE MASTER	AMENDING THE MASTER
PHOTOSTAT	Photographic paper negative (positive reading)	Photograph the original in the Photostat apparatus, develop, fix, wash, dry the negative, or print wet	Paint out unwanted parts or insert corrections where possible with white ink
REFLEX (Silver Halide)	Photographic negative (paper or film)	E.C.O. process	Only minor corrections possible on the negative, as above
DIRECT POSITIVE (Silver Halide)	Positive on translucent paper or material	E.C.O. process or stabilize	Minor corrections only
AZOFLEX (OCÉ)	Reflex transparent foil or transfer and translucent sheet	E.C.O. (reflex) develop or transfer	Minor corrections only
DIFFUSION TRANSFER	Special reflex paper, transfer paper or foil	E.C.O. develop with transfer paper or foil	Must be correct
VERIFAX	Special negative paper	E.C.O. develop	Must be correct
XEROGRAPHY	Xerox plate	Electrostatically charge the plate and expose via camera, develop with powder	Must be correct
THERMOFAX		No master is required	
PHOTRONIC REPRODUCER	Microfilm and electronically charged glass	Enlarge on metallic glass using vapourized ink	Must be correct
DYELINE BLUEPRINT	Translucent or transparent positive document	Draw on translucent material or prepare by photographic processes	Rubber eraser and redraw
TRUE TO SCALE (T.T.S.)	Inked reversed positive image on the T.T.S. composition	Expose ferro prussiate paper in contact with translucent master and lay down on table – ink	Minor amendments only after laying down
SILK SCREEN	Stencil	Cut out by hand or prepare photographically	Correct stencil
TRANSLUCENT MASTER	Translucent paper	Type with special typewriter ribbon, or normal ribbon with carbon paper behind, and in contact with the translucent master	Erase with rubber
SPIRIT PROCESS (Rotary)	Hectographic carbon deposit on art paper	Write, draw or type on art paper in contact with hectographic carbon or ribbon	Use rubber or plastic eraser and rewrite or retype. Corrections can be pasted on the master
AZOGRAPH CHEMOGRAPH	Diazo carbon deposit on transfer sheet	As above with special carbon	As above

Note: E.C.O.—Expose in contact with the original.
Process—Developing, fixing, washing and drying.

CONSUMABLES	MACHINES AND EQUIPMENT	ANCILLARY APPARATUS REQUIRED	DEGREE OF SKILL REQUIRED
Photographic paper and chemicals	Photostat camera	Processing – drying – trimmer	Training
Reflex paper – film – chemicals	Reflex exposing apparatus	Processing – drying – trimmer. Stabilization apparatus when used	Instructional. More experience for large sizes
Direct positive paper and chemicals	Reflex apparatus fitted with powerful lights or diazo machines	Processing or stabilizing	Instructional
Foil – transfer sheets – chemicals	Special exposing apparatus, rotary or non-rotary	Developing or transferring	Instructional
Special reflex paper, transfer paper or foil and chemicals	Small box or continuous exposing apparatus. Developing apparatus	Some machines are self-contained	Instructional
Verifax paper and chemicals	Verifax or Instant copier	Machines are self-contained	Instructional
Developing powder	Xerox copying camera. Charging and developing apparatus	Powder developing equipment	Instructionla
Thermofax paper only	Thermofax	None required	Instructional
Microfilm and ink	Camera-electronic spray		Instructional
Tracing paper or linen. Photographic film or paper. Chemicals	Drawing office equipment or photographic	Pens, ink, etc. or photographic materials	Training
Ferro prussiate paper – litho ink – composition for table	Photo copying machine – T.T.S. table	Melting urns for composition	Training
Paper, carbon tissue, inks	Silk Screen press	Exposing apparatus	Training
Translucent paper and ribbon	Typewriter	Pen - pencil - ink	Typist (trained)
Art paper, hectographic carbon (sheet, ribbon or roll)	Typewriter or Stylo	Writing and drawing accessories	Instructional
Transfer paper, Azograph sheet	Typewriter	As above	Training

PROCESS	TYPE OF MASTER	METHOD OF MAKING THE MASTER	AMENDING THE MASTER
Stencil			
A. Written or typed	Cellulose stencil	Write, draw, type or use printer's type-face to cut stencil	Apply correcting fluid and rewrite or retype
B. Sensitized	Sensitized stencil	Expose sensitized stencil in contact with translucent original, or by photoscope. Develop and dry the exposed stencil	The original must be correct
C. Electronic	Carbon coated stencil	Cut by electronic machine	The original must be correct
Offset			
A. Plastic plate			
1. Typed or written	Plastic plate	Write, draw, type, use printer's type-face	Use rubber eraser or special fluid and rewrite or retype
2. Sensitized	Sensitized plastic plate	Prepare a negative (film or paper), expose in contact with plate to light. Process	The master must be correct
B. Metal plate			
1. Direct	Metal plate	Write, draw, type, use printer's type-face	Use rubber or glass eraser or spirit, and rewrite or retype
2. Transfer	Metal plate	Write, type, draw or use printer's type-face to cut stencil. Use flat-bed duplicator to ink through the stencil to the plate. Use T.T.S. table	Amend stencil by using correcting fluid or amend plate by using rubber or glass eraser or spirit. Rewrite or retype
3. Photographic (*a*) Diapositive stencil	Metal Plate	Write, draw, type or use printer's type-face to cut diapositive stencil. Expose in contact with sensitized metal plate to light. Process	Use correcting fluid to amend stencil, rewrite or retype
(*b*) Photographic master (film or paper) N.B. A number of photographic methods are also able to prepare a direct image on a litho plate; e.g. Verifax, Xerography, Azoflex	Metal plate (*Note:* When deep-etched plates are needed, a positive must be exposed in contact with the sensitized plate)	Photograph the original to produce a negative (film or paper), retouch the negative, expose in contact with sensitized plate. Process	The original must be correct
Typeset	Type-face, half-tone or line blocks set up on a blanket segment or bed	Compose type-face, prepare half-tone or line blocks and assemble on blanket segment or bed	Re-arrange type-face
Microfilm			
Roll 16-35 mm.	Microfilm negative	Expose in microfilm camera	Must be correct
Microsheet	Sheet film microcopies	Expose in sheet film camera	Must be correct
70 mm. Half-plate	Roll or cut sheet negatives	Expose in special cameras	Must be correct
Addressing			
A. Metal plate	Metal plate	Use embossing machine to emboss characters on metal plate	Blank out incorrect characters and re-emboss
B. Stencil	Stencil held in cardboard frame	Damp stencil, type to cut the stencil	Use correcting fluid to amend – retype
C. Hectographic	Hecto master contained in a plastic frame	Type, write, using special paper	Use rubber or plastic eraser, retype, etc.

Note: E.C.O.—Expose in contact with the original.
Process—Developing, fixing, washing and drying.

CONSUMABLES	MACHINES AND EQUIPMENT	ANCILLARY APPARATUS REQUIRED	DEGREE OF SKILL REQUIRED
Cellulose stencils, carbon for proof	Typewriter	Wheel pen, Stylo and drawing accessories	Typist (trained)
Sensitized stencils, chemicals for developing	Exposing and developing unit		Instructional
Carbon stencil	Electronic scanning machine		Training
Plastic plates, litho ink, litho fluid	Typewriter	Writing and drawing accessories	Typist (trained)
Sensitized plates, negative film or paper, chemicals for processing	Exposing unit	Reflex copier, developing fixing and washing apparatus for negative making	Training
Metal plates, litho ink or ribbons, litho fluid	Typewriter	Writing and drawing accessories	Typist (trained)
Stencils, litho ink, proof paper, metal plates. French chalk, processing chemicals. T.T.S. materials	Typewriter	Wheel pen, Stylo and drawing accessories, flat-bed duplicator, T.T.S. table	Typist (trained) Instructional
Diapositive stencils, metal plates, sensitizing solution, developing ink, litho fluid	Typewriter Exposing unit	Wheel pen, Stylo, reading box, whirler, air dryer, facilities for washing and drying the plates	Typist (trained) Plate maker (trained)
Sensitized film or paper, developing chemicals, metal plates, sensitizing solution, developing ink, litho fluid	Process camera or other photographic apparatus	Half-tone screen, developing, fixing, washing and drying apparatus. Proof-reading box for re-touching, whirler, exposing unit, facilities for washing and drying the plates, also acid bath.	Training
Half-tone or line blocks and wear on type-face	Relief type	Composing forks, typesetter, blanket segments or type beds	Training
Film – chemicals	Stand or rotary	Viewers–processing apparatus	Instructional
Film–chemicals	Sheet film camera	As above	Training
Film–chemicals	Special apparatus	As above	Training
Plates – index cards, proof paper, inked ribbon	Embossing machine	Proofing machine – plate leveller	Training
Stencils, frames, proof paper	Typewriter (with stencil attachment)	Proofing machine – stencil damper	Training
Hecto master sheets	Typewriter (no special attachment required)	Proofing machine	Training

DUPLICATING COSTS
(including 40 minutes' Typing and Checking Time at 5s. per hour)

NO. OF COPIES	TRANSLUCENT MASTER	HECTOGRAPHY (SPIRIT)	STENCIL	OFFSET LITHOGRAPHY
10	4·2	4·75	5·5	5·2
20	2·5	2·25	2·91	2·75
30	1·9	1·8	2·04	1·92
40	1·6	1·4	1·6	1·51
50	1·4	1·2	1·3	1·26
75	1·2	0·81	0·91	0·93
100	1·1	0·75	0·82	0·77

The first task in any examination designed to indicate relative costs is to arrive at an acceptable figure which may express the amount of work an average operator will produce in a given period. Studies made of all the skills required in reproduction processes have indicated that a wide variation in output may be expected. This may be partially due to the dexterity of the individual operator but it is also influenced by numerous other factors. For instance the amount of work done by a typist would depend among other things on her familiarity with the language employed, the legibility of the script and the amount of layout or design which may be required.

With photocopying the output is determined chiefly by the type of apparatus used. A rotary machine should produce a higher output than a non-rotary model. Also the type and variety of work being copied will have some effect on the number of copies which may be produced in a given period. Old or faded documents, which, being brittle, will require careful handling, or documents having numerous colours, or those varying in size and shape will lower the output of any machine. Therefore the production of each copy will be more costly, in comparison, than those produced from good-quality originals of the same type and size which enable a very high output to be maintained.

The cost of the duplicating methods is also greatly influenced by the speed of the machine and in particular by the number of copies required from each master. The preparation of multi-colour prints which will necessitate each copy being repeatedly passed through the machine in perfect registration, and also of good quality half-tone prints which may need very careful inking, will have a considerable

influence on the output obtainable and therefore on the cost of these processes.

It is particularly necessary when making a cost examination to avoid short-period tests with the use of a stop-watch. By checking the output of any machine operator for a minute, and multiplying this by sixty to get an hourly output and by eight to arrive at a daily figure, it is possible to obtain results which bear no factual relationship to the actual output obtained under normal production conditions.

When first preparing some of the charts from which the cost ratios were compiled, speed tests were conducted with various operators for the purpose of comparison. Information was also collected from many reproduction sections, including those of the large industrial concerns. Owing to the numerous variables which exist it was impossible to find an acceptable figure on which a chart could be based because the results differed so widely.

Tests were therefore made which were designed to measure the amount of work individuals could do under given conditions. The results may bear no close relationship to similar tests which may be made with other operators under the same or dissimilar conditions but since they are derived from normal production work, it is felt that they are reasonably indicative of the average output of the processes examined.

Some of the photocopying tests were performed by the same operator after she had been trained on each process and had acquired a comparable degree of skill with each method. The same documents were used throughout the tests and all other conditions were designed to give figures which were as reliable as could be obtained.

With the newer processes which were not then generally available tests were undertaken at the firm's showrooms. A number of both skilled and unskilled operators were used to provide some acceptable output figure which may be expected from any normal operator. A realistic figure was finally agreed upon and this has been used in the cost estimation.

The comparison has been limited to 100 copies since it includes the photocopying methods which are only intended for small quantities. There would appear to be little controversy regarding the most suitable methods of reproduction for larger quantities but confusion does exist regarding the most economical process for short-run work. Single copy costs have also been included. When only one copy is required from an opaque original cost is usually secondary to convenience. Taking all things into consideration most of the processes do not vary widely in cost when one positive copy

only is wanted, unless the direct positive type of paper is used with methods which enable a positive copy to be made directly.

METHOD OF COSTING

As previously stated, material and labour costs only were considered in this examination. The materials supplied for these processes are normally subject to discount because they are generally used commercially. These discounts vary widely according to the quantities purchased. It was felt desirable to deduct the average discount from the retail material cost for medium quantities because this gives a more realistic figure to the majority of users.

A common figure has also been allowed for the cost of duplicating paper. This material is available in a wide variety both in quality and price, so that it is always possible to use paper of a similar cost irrespective of the process employed. It was therefore felt desirable to resolve paper costs to a single unit level at which all processes may be compared.

It has also been stated that the cost of incidental materials used in duplicating methods can have little effect on the final copy. A careful examination of these costs has indicated that they add more to the final copy than is generally imagined. For this reason any costing designed to produce realistic figures should not ignore the effects which such materials can give to the final answer.

The cost of typing was also disregarded, since this cost is common to all the duplicating processes. It may be considered that some forms of duplicating masters require less time to type than others but this is a debatable point because the skill of typists varies so much. This time therefore could only be determined for each individual typist and would depend on her familiarity with the type of master examined.

Where the reproduction of documents may be done either by using one of the photocopying processes or by typing and duplicating the cost of typing is of vital importance since it is this cost which allows the extended use of the more expensive sensitized papers. In a previous examination which was designed to find the relative costs of these two methods, it was found that by using a small rotary diazo machine the changeover in favour of duplicating was at about fifty copies. This test was conducted by typing and duplicating an article from a technical journal and also by making a translucent intermediate master from the original, and printing this on diazo paper. Less efficient apparatus or the use of other sensitized materials

REPRODUCTION INFORMATION CHARTS

having a great translucency would naturally disturb this factor and may reduce or increase the economic limit of this figure.

RUNNING COSTS OF DUPLICATION

The production cost of the duplicating processes must include the duplicating master and such other materials as are required to produce a copy. The spirit process uses a special fluid and the stencil method uses only ink, but offset lithography requires both ink and chemicals. These material costs were found to be much higher than anticipated. A recent examination indicated that with the spirit method there is some waste of fluid by evaporation which does increase the cost of reproduction. The same test indicated that stencil machines use considerably more ink than offset machines, the ink consumption differing according to the make of the machine. Offset machines, however, use various chemicals which are not required by other duplicating processes.

In addition to materials, both the make-ready and running-off times must also be considered. To prepare the following charts make-ready time was estimated from the moment the operator was given the printing master to the time when the first good copy was produced. To this was added the time taken to put the machine back into position to receive the new master which therefore included removing the old master and putting it away, cleaning down where necessary, replenishing the paper, adjusting the paper feed and re-inking if required. The number of masters examined to obtain these times exceeded 7,000.

The time differed with various operators and the type of machine used. It is generally agreed that the spirit process requires less make-ready time than any other duplicating process and that the offset needs perhaps the longest time. As the tests were being restricted to 100 copies paper plates only were used. Metal plates being prepared for long runs may require considerably more make-ready time, but this additional cost would be negligible if thousands of copies were being printed.

Tests made in a number of duplicating sections with different operators indicated that it took approximately 1 min. 45 sec. to run off 100 copies of 13 × 8 in. size which roughly is one copy per second. This figure was therefore used as a base for measurement.

When estimating the cost of diazo reproduction which has a variety of available paper sensitivities and machine speeds, some difficulty was presented. It was found that modern rotary apparatus can produce up to 500 copies per hour under favourable conditions.

A realistic figure of 200 per hour was finally agreed as being within the capabilities of all average operators, and a fair estimate of the possible output of the small rotary diazo machine which is now so widely used. Where the smaller diazo machines which produce about 100 copies per hour are used, some allowance for this reduced output must be made. Machines of the OCÉ Azoflex E 50 type which are able to produce up to 1,500 prints an hour are specialist machines and as such are therefore not considered in this examination.

TABLES OF COMPARATIVE COSTS

THE FOLLOWING TABLES have been worked out to give the relative costs of making 100 copies, 13 × 8 in., by all the available reproduction processes. They are determined by estimating the material and labour costs of both the master and the copy. The photocopying machines were of medium speed worked under normal conditions with the staff fully employed.

The master used on the duplicating processes was of the low-run type and therefore cheap. More expensive masters, particularly zinc plates for the offset process, would considerably disturb this cost ratio. The production of many thousands of copies for which such masters are intended would, however, make this additional cost almost negligible.

Process: REFLEX (S.H.)

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 5·0
Copies 5·0

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	5·0	5·0	10·0	10·00
2	5·0	10·0	15·0	7·50
3	5·0	15·0	20·0	6·66
4	5·0	20·0	25·0	6·25
5	5·0	25·0	30·0	6·00
6	5·0	30·0	35·0	5·83
7	5·0	35·0	40·0	5·71
8	5·0	40·0	45·0	5·62
9	5·0	45·0	50·0	5·55
10	5·0	50·0	55·0	5·50
15	5·0	75·0	80·0	5·33
20	5·0	100·0	105·0	5·25
30	5·0	150·0	155·0	5·16
40	5·0	200·0	205·0	5·12
50	5·0	250·0	255·0	5·10
75	5·0	375·0	380·0	5·06
100	5·0	500·0	505·0	5·05

Process: PHOTOSTAT

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 5·58
Copies 6·28

The production time required for making the copy being in excess of that necessary for the negative adds slightly to its cost.

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	5·58	6·28	11·86	11·86
2	5·58	12·56	18·14	9·07
3	5·58	18·84	24·42	8·14
4	5·58	25·12	30·70	7·67
5	5·58	31·40	36·98	7·39
6	5·58	37·68	43·26	7·21
7	5·58	43·96	49·54	7·08
8	5·58	50·24	55·82	6·98
9	5·58	56·52	62·10	6·90
10	5·58	62·80	68·38	6·83
15	5·58	94·20	99·78	6·65
20	5·58	125·60	131·18	6·55
30	5·58	188·40	193·98	6·46
40	5·58	251·20	256·78	6·41
50	5·58	314·00	319·58	6·39
75	5·58	471·00	476·58	6·35
100	5·58	628·00	633·58	6·33

Process: DIRECT POSITIVE PAPER

(Double-sided original using an intermediate master)

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 5·5
Copies 5·0 *

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	5·0	5·0	10·0	10·0
2	5·0	10·0	15·0	7·5
3	5·0	15·0	20·0	6·6
4	5·0	20·0	25·0	6·2
5	5·0	25·0	30·0	6·0
6	5·0	30·0	35·0	5·8

* each side

These costs were made by using a non-continuous exposing machine with a continuous developer and stabilizer. Continuous exposing apparatus or the simultaneous exposure of a number of sheets, or the development of two sheets together would reduce the above costs. The use of the porous block method of processing would increase the costs given.

Process: DIRECT-POSITIVE PAPER INTERMEDIATE AND DIAZO COPIES

COST OF MATERIALS AND LABOUR (5S. PER HOUR)

Master 5·5
Copies 0·97

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	5·5	0·97	6·47	6·47
2	5·5	1·94	7·44	3·72
3	5·5	2·91	8·41	2·8
4	5·5	3·88	9·38	2·34
5	5·5	4·85	10·35	2·07
6	5·5	5·82	11·32	1·88
7	5·5	6·79	12·29	1·75
8	5·5	7·76	13·26	1·65
9	5·5	8·73	14·23	1·58
10	5·5	9·70	15·20	1·52
15	5·5	14·55	20·05	1·33
20	5·5	19·40	24·90	1·24
30	5·5	29·10	34·6	1·15
40	5·5	38·80	44·30	1·1
50	5·5	48·50	54·00	1·08
75	5·5	72·75	78·25	1·04
100	5·5	97·00	102·5	1·02

A small additional cost has been allowed in the preparation of the master because of the quality required for multiple copies.

Process: DIFFUSION TRANSFER INTERMEDIATE AND DIAZO COPIES

COST OF MATERIALS AND LABOUR (5S. PER HOUR)

Master 15·5
Copies 0·97

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	15·5	0·97	16·47	16·47
2	15·5	1·94	17·44	8·72
3	15·5	2·91	18·41	6·13
4	15·5	3·88	19·38	4·84
5	15·5	4·85	20·35	4·07
6	15·5	5·82	21·32	3·55
7	15·5	6·79	22·29	3·18
8	15·5	7·76	23·26	2·91
9	15·5	8·73	24·23	2·69
10	15·5	9·70	25·20	2·52
15	15·5	14·55	30·05	2·00
20	15·5	19·40	34·90	1·74
30	15·5	29·10	44·60	1·48
40	15·5	38·80	54·30	1·35
50	15·5	48·50	64·00	1·28
75	15·5	72·75	88·25	1·17
100	15·5	97·00	112·50	1·12

Process: VERIFAX

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 7·963
Copies 1·26

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	7·963	1·26	9·223	9·22
2	7·963	2·52	10·483	5·24
3	7·963	3·78	11·743	3·91
4	7·963	5·04	13·003	3·25
5	7·963	6·30	14·263	2·85
6	7·963	7·56	15·523	2·58

Process: AZOFLEX (REFLEX FOIL AND DIAZO)

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 17·72
Copies 0·97

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	17·72	0·97	18·69	18·69
2	17·72	1·94	19·66	9·83
3	17·72	2·91	20·63	6·87
4	17·72	3·88	21·60	5·40
5	17·72	4·85	22·57	4·51
6	17·72	5·82	23·54	3·92
7	17·72	6·79	24·51	3·50
8	17·72	7·76	25·48	3·18
9	17·72	8·73	26·45	2·93
10	17·72	9·70	27·42	2·74
15	17·72	14·55	32·27	2·15
20	17·72	19·40	37·12	1·85
30	17·72	29·10	46·82	1·56
40	17·72	38·80	56·52	1·41
50	17·72	48·50	66·22	1·32
75	17·72	72·75	90·47	1·20
100	17·72	97·00	114·72	1·14

Process: AZOFLEX (TRANSFER FOIL AND DIAZO)

COST OF MATERIALS AND LABOUR (5S. PER HOUR)

Master 24·5
Copies 0·97

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	24·5	0·97	25·49	25·49
2	24·5	1·94	26·44	13·22
3	24·5	2·91	27·41	9·10
4	24·5	3·88	28·38	7·09
5	24·5	4·85	29·35	5·87
6	24·5	5·82	30·32	5·05
7	24·5	6·79	31·29	4·47
8	24·5	7·76	32·26	4·03
9	24·5	8·73	33·23	3·69
10	24·5	9·70	34·20	3·42
15	24·5	14·55	39·05	2·60
20	24·5	19·40	43·90	2·19
30	24·5	29·10	53·60	1·78
40	24·5	38·80	63·30	1·58
50	24·5	48·50	73·00	1·46
75	24·5	72·75	97·25	1·29
100	24·5	97·00	121·50	1·21

Process: AZOFLEX. TRANSFER FOIL AND OFFSET PLATE (METAL)

COST OF MATERIALS AND LABOUR (5S. PER HOUR)

Master 52·1 *
Copy 0·29

NUMBER OF COPIES	PRODUCTION COST OF OFFSET PLATE Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	52·1	0·29	52·39	52·39
2	52·1	0·58	52·68	26·34
3	52·1	0·87	52·97	17·65
4	52·1	1·16	53·26	13·31
5	52·1	1·45	53·55	10·71
6	52·1	1·74	53·84	8·97
7	52·1	2·03	54·13	7·73
8	52·1	2·32	54·42	6·80
9	52·1	2·61	54·71	6·07
10	52·1	2·90	55·00	5·50
15	52·1	4·35	56·45	3·76
20	52·1	5·80	57·90	2·89
30	52·1	8·70	60·80	2·02
40	52·1	11·60	63·70	1·59
50	52·1	14·50	66·60	1·33
75	52·1	21·75	73·85	·98
100	52·1	29·00	81·10	·81

* Including a generous allowance for retouching the plate.

Process: XEROGRAPHY

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 6·50
Copies 1·25

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	6·50	1·25	7·75	7·75
2	6·50	2·50	9·00	4·50
3	6·50	3·75	10·25	3·41
4	6·50	5·00	11·50	2·87
5	6·50	6·25	12·75	2·55

Process: XEROGRAPHY AND OFFSET PLATE (PAPER)

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 18
Copy 0·29

NUMBER OF COPIES	PRODUCTION COST OF OFFSET PLATE Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	18	0·29	18·29	18·29
2	18	0·58	18·58	9·29
3	18	0·87	18·87	6·29
4	18	1·16	19·16	4·79
5	18	1·45	19·45	3·89
6	18	1·74	19·74	3·29
7	18	2·03	20·03	2·86
8	18	2·32	20·32	2·54
9	18	2·61	20·61	2·29
10	18	2·90	20·90	2·09
15	18	4·35	22·35	1·49
20	18	5·80	23·80	1·19
30	18	8·70	26·70	·89
40	18	11·60	29·60	·74
50	18	14·50	32·50	·65
75	18	21·75	39·75	·53
100	18	29·00	47·00	·47

Process: ELECTRONIC STENCIL (Service cut) and Duplicating

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 186·0 Copies 0·3

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	186·0	0·3	186·3	186·3
2	186·0	0·6	186·6	93·3
3	186·0	0·9	186·9	62·3
4	186·0	1·2	187·2	46·8
5	186·0	1·5	187·5	37·5
6	186·0	1·8	187·8	31·3
7	186·0	2·1	188·1	26·87
8	186·0	2·4	188·4	23·55
9	186·0	2·7	188·7	20·96
10	186·0	3·0	189·0	18·9
15	186·0	4·5	190·5	12·7
20	186·0	6·0	192·0	9·6
30	186·0	9·0	195·0	6·5
40	186·0	12·0	198·0	4·95
50	186·0	15·0	201·0	4·02
75	186·0	22·5	208·5	2·78
100	186·0	30·0	216·0	2·16

The cost of an Electronic Stencil is 15s. 6d. including Tax. This type of stencil is limited to same size copies. Additional charges are made for any art work required on the original.

Process: ELECTRONIC STENCIL (cut within the section) and Duplicating

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 104·0 Copies 0·3

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	104·0	0·3	104·3	104·3
2	104·0	0·6	104·6	52·3
3	104·0	0·9	104·9	34·96
4	104·0	1·2	105·2	26·3
5	104·0	1·5	105·5	21·1
6	104·0	1·8	105·8	17·63
7	104·0	2·1	106·1	15·15
8	104·0	2·4	106·4	13·3
9	104·0	2·7	106·7	11·85
10	104·0	3·0	107·0	10·7
15	104·0	4·5	108·5	7·23
20	104·0	6·0	110·0	5·50
30	104·0	9·0	113·0	3·76
40	104·0	12·0	116·0	2·9
50	104·0	15·0	119·0	2·38
75	104·0	22·5	126·5	1·68
100	104·0	30·0	134·0	1·34

The average Time required to cut a full 13 × 8 in. stencil is about 20 minutes. This time cost has been added to the material cost but the operator could utilize some of this period.

Process: PHOTOSCOPE STENCIL (Service cut) and Duplicating

COST OF MATERIALS AND LABOUR (5S. PER HOUR)

Master 158·0 Copies 0·3

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	158·0	0·3	158·3	158·3
2	158·0	0·6	158·6	79·3
3	158·0	0·9	158·9	52·96
4	158·0	1·2	159·2	39·8
5	158·0	1·5	159·5	31·9
6	158·0	1·8	159·8	26·63
7	158·0	2·1	160·1	22·87
8	158·0	2·4	160·4	20·05
9	158·0	2·7	160·7	17·85
10	158·0	3·0	161·0	16·10
15	158·0	4·5	162·5	10·83
20	158·0	6·0	164·0	8·2
30	158·0	9·0	167·0	5·56
40	158·0	12·0	170·0	4·25
50	158·0	15·0	173·0	3·46
75	158·0	22·5	180·5	2·4
100	158·0	30·0	188·0	1·88

The basic charge for making a photoscope stencil is 13s. 2d. For sizes varying from that of the original the charge is 22s. 6d. Half tones are 7s. 6d. extra. These additional charges must be added to the above costs if these stencils are used.

Process: PHOTOSCOPE STENCIL (prepared within the section) and Duplicating

COST OF MATERIALS AND LABOUR (5S. PER HOUR)

Master 45·0 Copies 0·3

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	45·0	0·3	45·3	45·3
2	45·0	0·6	45·6	22·8
3	45·0	0·9	45·9	15·3
4	45·0	1·2	46·2	11·55
5	45·0	1·5	46·5	9·3
6	45·0	1·8	46·8	7·8
7	45·0	2·1	47·1	6·72
8	45·0	2·4	47·4	5·92
9	45·0	2·7	47·7	5·3
10	45·0	3·0	48·0	4·8
15	45·0	4·5	49·5	3·3
20	45·0	6·0	51·0	2·55
30	45·0	9·0	54·0	1·8
40	45·0	12·0	57·0	1·42
50	45·0	15·0	60·0	1·2
75	45·0	22·5	67·5	·9
100	45·0	30·0	75·0	·75

Process: TRANSLUCENT STATIONERY AND DIAZO

COST OF MATERIALS AND LABOUR (5S. PER HOUR)
Master 0·25 * Copies 0·97

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	0·25	0·97	1·22	1·22
2	0·25	1·94	2·19	1·09
3	0·25	2·91	3·16	1·05
4	0·25	3·88	4·13	1·03
5	0·25	4·85	5·10	1·02
6	0·25	5·82	6·07	1·01
7	0·25	6·79	7·04	1·00
8	0·25	7·76	8·01	1·00
9	0·25	8·73	8·98	·99
10	0·25	9·70	9·95	·90
15	0·25	14·55	14·80	0·98
20	0·25	19·40	19·65	0·98
30	0·25	29·10	29·35	0·97
40	0·25	38·80	39·05	0·97
50	0·25	48·50	48·75	0·97
75	0·25	72·75	73·00	0·97
100	0·25	97·00	97·25	0·97

* Typing costs not included.

Process: HECTOGRAPHIC SPIRIT

COST OF MATERIALS AND LABOUR (5S. PER HOUR)
Master 4·5 * Copies 0·3

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	4·5	0·3	4·8	4·8
2	4·5	0·6	5·1	2·55
3	4·5	0·9	5·4	1·80
4	4·5	1·2	5·7	1·42
5	4·5	1·5	6·0	1·20
6	4·5	1·8	6·3	1·05
7	4·5	2·1	6·6	0·94
8	4·5	2·4	6·9	0·86
9	4·5	2·7	7·2	0·80
10	4·5	3·0	7·5	0·75
15	4·5	4·5	9·0	0·60
20	4·5	6·0	10·5	0·52
30	4·5	9·0	13·5	0·45
40	4·5	12·0	16·5	0·41
50	4·5	15·0	19·5	0·39
75	4·5	22·5	27·0	0·36
100	4·5	30·0	34·5	0·34

* Typing costs not included.

The masters used for the preparation of the costs were of the cheaper type designed for 100 copies. Master packs or other expensive masters particularly those used in the non-stain processes would increase the costs given.

Process: STENCIL

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 12·3 * Copies 0·3

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	12·3	0·3	12·6	12·6
2	12·3	0·6	12·9	6·45
3	12·3	0·9	13·2	4·4
4	12·3	1·2	13·5	3·37
5	12·3	1·5	13·8	2·76
6	12·3	1·8	14·1	2·35
7	12·3	2·1	14·4	2·05
8	12·3	2·4	14·7	1·83
9	12·3	2·7	15·0	1·66
10	12·3	3·0	15·3	1·53
15	12·3	4·5	16·8	1·12
20	12·3	6·0	18·3	·91
30	12·3	9·0	21·3	·71
40	12·3	12·0	24·3	·60
50	12·3	15·0	27·3	·54
75	12·3	22·5	34·8	·46
100	12·3	30·0	42·3	·42

* Typing costs not included.

Process: OFFSET LITHOGRAPHY

COST OF MATERIALS AND LABOUR (5s. PER HOUR)

Master 9·5 * Copies 0·277

NUMBER OF COPIES	PRODUCTION COST OF PRINTING MASTER Pence	PRODUCTION COST OF COPIES Pence	TOTAL COST Pence	COST PER COPY Pence
1	9·5	0·277	9·777	9·78
2	9·5	0·554	10·054	5·02
3	9·5	0·831	10·331	3·44
4	9·5	1·108	10·608	2·65
5	9·5	1·385	10·885	2·17
6	9·5	1·662	11·162	1·86
7	9·5	1·939	11·439	1·63
8	9·5	2·216	11·716	1·46
9	9·5	2·493	11·993	1·33
10	9·5	2·770	12·27	1·22
15	9·5	4·155	13·655	0·91
20	9·5	5·540	15·040	0·75
30	9·5	8·310	17·810	0·59
40	9·5	11·080	20·580	0·51
50	9·5	13·850	23·350	0·46
75	9·5	20·775	30·275	0·40
100	9·5	27·700	37·200	0·37

* Typing costs not included.

Document Reproduction

FROM AN EXISTING ORIGINAL. SIZE 13 × 8 INCHES

1–100 *Copies. Cost in pence for materials and labour only.* (*5s. per hour*)

	Single Copies	No. of Copies — Cost per copy 2	3	4	5	6	7	8	9	10	15	20	30	40	50	75	100
Reflex (S.H.)	10·0	7·5	6·6	6·2	6·0	5·8	5·7	5·6	5·5	5·5	5·3	5·2	5·2	5·1	5·1	5·1	5·1
Photostat																	
Readable Negative	6·0	Single copy technique															
Positive Copy	11·9	9·1	8·2	7·7	7·4	7·2	7·1	7·0	6·9	6·8	6·7	6·6	6·5	6·4	6·4	6·4	6·3
Direct-Positive Paper																	
Single Sided Original	5·0	Each copy will be about the same cost															
Double Sided Original intermediate and positive	10·0	7·5	6·6	6·2	6·0	5·8											
B1 Reflex	5·5	Used for single copies only															
Direct-Positive Intermediate and Diazo	6·5	3·7	2·8	2·3	2·1	1·8	1·7	1·7	1·6	1·5	1·3	1·2	1·1	1·1	1·0	1·0	1·0
Diffusion Transfer	9·5	9·5	One off each Negative														
Opaque		6·8	Two off each Negative														
Translucent and Diazo	16·5	8·7	6·1	4·8	4·1	3·5	3·2	3·0	2·7	2·5	2·0	1·7	1·5	1·4	1·3	1·2	1·1
Verifax																	
Opaque Copies	9·2	5·2	4·0	3·2	2·9	2·5											
Translucent and Diazo	11·0	5·9	4·3	3·5	3·0	2·6	2·4	2·2	2·1	2·0	1·6	1·5	1·3	1·2	1·2	1·1	1·1
Offset Plate																	
Thermofax	6·8	Each copy will be about the same cost															

Document Reproduction

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1–100 *Copies. Cost in pence for materials and labour only.* (*5s. per hour*)

AZOFLEX																	
Reflex Foil	18·7	9·9	6·9	5·4	4·5	3·9	3·5	3·2	3·0	2·8	2·2	1·9	1·6	1·4	1·3	1·2	1·2
Transfer Foil	25·5	13·2	9·1	7·1	5·9	5·0	4·5	4·0	3·7	3·5	2·6	2·2	1·8	1·6	1·5	1·3	1·2
Offset Plate	52·4	26·3	17·7	13·3	10·7	9·0	7·7	6·8	6·7	5·5	3·8	2·9	2·0	1·6	1·3	1·0	0·8
XEROGRAPHY																	
Direct Copies	7·8	4·5	3·4	2·9	2·5												
Offset Plate	18·3	9·3	6·3	4·8	3·9	3·3	2·9	2·5	2·3	2·1	1·5	1·2	0·9	0·7	0·6	0·5	0·5
ELECTRONIC STENCIL (service cut) AND DUPLICATING	186·3	93·3	62·3	46·8	37·5	31·3	26·9	23·5	21·0	18·9	12·7	9·6	6·5	4·9	4·0	2·8	2·2
ELECTRONIC STENCIL (made in the section) AND DUPLICATING	104·3	52·3	35·0	26·3	21·1	17·6	15·1	13·3	11·8	10·7	7·2	5·5	3·8	2·9	2·4	1·7	1·3
PHOTOSCOPE STENCIL (service cut) AND DUPLICATING	158·3	79·3	53·0	39·8	31·9	26·6	22·9	20·0	17·9	16·1	10·8	8·2	5·6	4·2	3·5	2·4	1·9
PHOTOSCOPE STENCIL (made in the section) AND DUPLICATING	45·3	22·8	15·3	11·5	9·3	7·8	6·7	5·9	5·3	4·8	3·3	2·5	1·8	1·4	1·2	0·9	0·8

Estimated to a near decimal.

Duplicating Processes

FROM A MASTER PREPARED BY TYPING

Summary of Costs for 1–100 *copies, not including the cost of typing the Master. Materials and Labour* (5*s. per hour*)

Process	No. of Copies																
	1	2	3	4	5	6	7	8	9	10	15	20	30	40	50	75	100
Translucent Master and Diazo	1·22	1·1	1·05	1·03	1·02	1·01	1·01	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0	1·0
Hectographic (Spirit	4·8	2·5	1·8	1·4	1·2	1·05	1·0	0·9	0·8	0·7	0·6	0·5	0·45	0·41	0·39	0·36	0·34
Stencil	12·6	6·45	4·4	3·37	2·76	2·35	2·05	1·83	1·66	1·53	1·12	0·91	0·7	0·60	0·54	0·46	0·42
Offset Lithography	9·8	5·02	3·44	2·7	2·2	1·9	1·6	1·5	1·3	1·2	0·9	0·8	0·6	0·5	0·5	0·4	0·4

N.B.—*The cost of Typing the Master must be added to the above figures.*

The cheapest type of Master material has been used for each process.

CHAPTER XLVI

CENTRALIZATION

THE GROWING DEVELOPMENT of document reproduction and the present-day trends of extending this field to include that previously covered by the professional printing house, makes it desirable that duplicating sections should be fully equipped and organized to undertake the various types of work now required of them. The small departmental installation can never be adequately equipped to produce such a wide variety of work, since this would require an excess of machines and staff which could not be kept economically employed.

As a general rule these small sections are inadequately equipped, the apparatus is often old, ill-used and infrequently cleaned. Lack of expert supervision or of interest by those who only occasionally do this type of work results in a serious waste of materials and labour and in the production of work of an extremely poor quality. Therefore, where reproduction is done in a number of smaller sections within a large organization, it may be found desirable to centralize all the photographic and allied processes, making their services available to the organization as a whole and thereby justifying the use of a wide range of machines and processes.

To be effective and economical, reproduction work must be properly organized and supervised. The equipment should preferably be electrically operated and able to produce a maximum output with the minimum of labour. This can only be achieved when the load of work is sufficient to justify a variety of superior apparatus, which is able to meet all the requirements of the organization.

That there are both advantages and disadvantages in a central organization cannot be denied. Departmental reproduction permits work of an urgent and individual nature to be given the necessary attention. Such a service frequently results in increasing the cost of reproduction, but where it is genuinely required the individual service may be an advantage. If a central section is conveniently situated within an organization, it is possible that the same individual

service may also be available, but unfortunately the personal touch is often lost in a larger department.

Where the reproduction work of a department is part of the general work within the section to which it is attached, the claim for departmental organization is perhaps reasonable. As an alternative, the duplicating masters can be prepared within the originating department and reproduced quickly and economically in a central duplicating section. This compromise is generally acceptable when the preparation of the master cannot be made outside the section to which it is related.

Departments which are widely separated from the main organization may also claim a right to an individual reproduction unit. The labour involved in making out a requisition, recording both the dispatch and receipt of the work, and the conveyance to and from the departments concerned must be taken into consideration against the advantages of the central organization. However, much of this work can be avoided by having printed forms and gummed labels which will avoid unnecessary labour. The forms should contain full details of the type of work generally done and require only the barest information added to complete and convey an adequate order to the reproduction staff. The labels allow the order to be dispatched with the minimum of effort, and if a return label is enclosed with the order the work within the reproduction section will also be correspondingly reduced.

When centralization is felt to be desirable it may be undertaken either in groups or as a single and complete unit. It is possible to centralize the work of a number of offices or departments and to provide a common service for these. Where sections of an organization are separated, there are advantages in this method. One of these small centralized sections can be fitted with any special apparatus which may be only infrequently used and this can provide a service for the other sections, undertaking this specialized work when required.

The advantages given by a large centralized unit can be briefly summarized. The work is more evenly distributed, and machines, staff and space are more economically employed.

The combined demands of all sections are sufficient to justify the employment of good, modern apparatus which is able to produce a maximum output with a minimum of labour costs, an important consideration in these days of high wages.

The central unit is able to deal with large urgent jobs more readily than the small installation. It is also able to undertake a wider variety of work since it can be equipped with special machines,

some of which may not be in constant use but are justified by the frequent demands made from a number of departments.

All reproduction apparatus, however simple, requires in addition some ancillary equipment. Guillotines, stapling, stitching, plate-making and similar machines are often an essential part of the section. The small departmental unit may not justify such equipment, or at least only of a simple hand-operated type which will add considerably to the labour costs.

The work of a central branch is also less hampered by holidays and sick leave. The absence of one member of the staff from a small unit may well disrupt the flow of work completely. It may also be found that some small sections within a large organization may be working overtime while other sections within the same concern are not fully employed. Reproduction work, by its nature, is bound to ebb and flow. In a centralized unit the work can be diverted to processes which are free to undertake it, or staff may be moved to operate vacant machines or assist where the pressure is greatest.

Perhaps the chief advantage of the centralized section is that it justifies the employment, at a reasonable salary, of a supervisor who is familiar with all the processes. He can thus direct and organize these methods to greater efficiency and at the same time keep his executives fully aware of all the new methods and machines as they are made available. This man can also act as an assessor when complaints arise, or when one section blames another if things go wrong. It is by no means unusual for machine operators to blame their machines or the printing master they are using, when their work is not of a high standard. It is natural for the plate-makers to blame the photographer for the half-tone or line negative supplied and for a machine operator to blame both. These complaints require careful investigation by an experienced controller whose judgment is respected by the staff concerned.

Since all demands would pass through the supervisor's office, he would be able to direct them to the most suitable process. In addition he would, if required, question the necessity for production or the suitability of a particular method which may have been requested. Reproduction processes are open to misuse and a careful watch must be kept on all requests received. Much of the misuse is due to ignorance, and demands for a large number of photocopies are usually the result of lack of knowledge or understanding regarding the limitations of these processes.

An experienced manager can also do much to make the section run smoothly and economically and produce work of a quality not normally obtainable in the small departments. He can also advise

on the preparation of drafts, drawings and other illustrations, and organize the work by the use of materials which enables reproduction to be done by the most economical method. His duties would also include the interviewing of all firms' representatives and new staff, thus saving the time of higher executives.

As a focal point, centralization has also many other advantages. It can justify a storehouse which can have adequate heat and ventilation instead of the material being packed in cupboards and corridors. Consumables can then be delivered directly to the main store, examined and checked by the clerk, who can also keep a careful watch on the available stock and be responsible for re-ordering when necessary, thus avoiding the delays which so frequently occur when stock becomes depleted without it being noticed.

Under the direction of a capable supervisor, a centralized unit should be efficient and economical. It will produce work of a far higher standard and of a greater variety than can be obtained by the small sections, which so often muddle along without organization or direction and therefore without any standards of quality.

CHAPTER XLVII

SPECIAL TYPEWRITERS AND COMPOSING MACHINES

THE APPEARANCE of the final copy produced by duplicating methods is not generally of the same high standard as that given by letterpress and other printing processes. A number of factors contribute to this loss of quality, but chiefly it is due to the use of the normal typewriter in the preparation of the printing master.

The three important features which enable letterpress work to be easily distinguished from that given by normal typewriters are (1) the type face used, (2) differential spacing, (3) justification of line. Type faces and their characteristics have been discussed under Relief Printing. Differential spacing is a term used to indicate that each character is spaced according to its individual width. The average typewriter is able to give only unit spacing in which each letter, irrespective of its size, occupies one unit of space. Thus, a character such as an 'i' will be given the same area as the wider letters, such as 'w' or 'm'. In differential spacing, the narrow letters are proportionately spaced according to their size, thereby producing a more professional and pleasing appearance.

Line justification is a printer's term, indicating that the right-hand edge of the printing area is an even line, having the last letter of each line directly below the last letter on the line above it, as in the present book. Using a normal typewriter, this is very difficult to achieve and the ragged, uneven edges usually associated with typewritten work tend to destroy the neat appearance of the final copy.

A material known as Justi-type is available by which it is possible to justify lines by one direct typing in an ordinary typewriter. This material is a stretchable paper laminated lightly to a pressure sensitive sheet and is supplied in strips of line width. These are typed in the normal manner but short lines are lifted and stretched to align with the previous line. They are then pressed back on to the pressure sheet which will hold them in the correct position.

To assist in obtaining good justified copy the backing sheet is printed with non-photographic blue lines which enables the typist

to set the margins and also provides a fixed line for stretching. Corrections can be made by painting with a special fluid and re-typing or the new word may be spliced into its proper place. Where whole lines have to be retyped the faulty line can be lifted off the backing sheet and a new line let in to replace it.

It is said for this method that distortion is negligible because the spacing is accomplished between the typed characters. The colour of the Justi-type paper is suitable for subsequent reproduction by the offset or stencil processes.

To give a quality of reproduction more closely resembling that given by the letterpress machines, normal typewriters can be supplied with special type faces which will give an improved appearance. Machines are also available which can give both differential spacing and line justification and therefore produce the easy readability of a well-printed copy.

Most of these special machines are electrically operated, a desirable feature with typewriters designed to produce masters for duplication. The particular advantage of the power-operated machine is that the strike is mechanically controlled to give an even pressure, according to the size of the character being used. It is not generally realized that the capital letters, such as 'M' or 'W', require considerably more force to produce a well-defined character than is required for a full stop or a comma. Good typists, who are aware of this requirement, will produce masters able to be reproduced satisfactorily, but the use of the electric machine will improve the results where the typist is not fully experienced in this special class of work. For this reason, the use of the power-operated machine is preferable when duplicating masters are being prepared.

The International Business Machines range of electric typewriters includes the well-known Executive model, which can be supplied fitted with special type face, but each machine can have only one style of type. These machines are also able to justify the line by double typing and to produce distinctive results, which are pleasant to read and add much to the quality of the finished result. To make it possible to use special characters, a demountable type-bar is provided for use with both the IBM Standard and Executive models. These bars can be changed by the typist quickly and easily, without the use of any tools or gadgets. This method provides a helpful modification to the keyboard and the wide selection of available characters makes it useful for this occasional work.

The Adler manually operated machine, made in Germany but available in this and other countries, is also able to give margin justification.

The Varityper is one of the more important additions to this range of special typewriters. Three models are generally available, the better of these being known as the Varityper Coxhead D.S.J. This model is classed as an office composing machine and, as its title (D.S.J.) indicates, is able to give both *d*ifferential *s*pacing and line *j*ustification. It is able to use a wide variety of styles of type face, ranging in size from six to twelve point. These are contained on small semi-circular founts or segments, which can be quickly fitted to and removed from the machine. These founts weigh less than one-fifth of an ounce and contain up to ninety characters, covering all the letters of the alphabet in upper and lower case, numerals and commonly used symbols. They are also available for many foreign alphabets and with

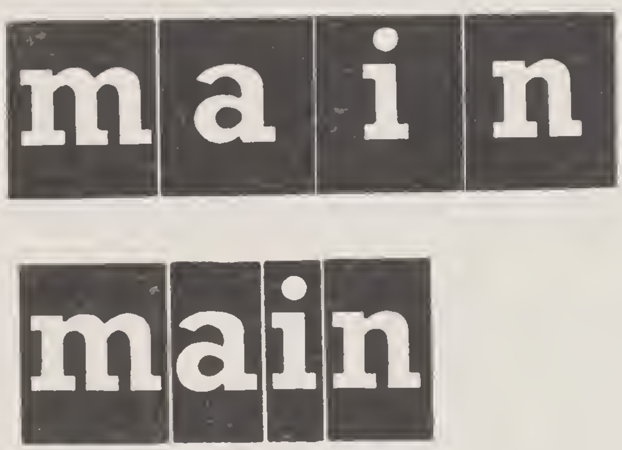


Fig. 38.

mathematical, chemical and other symbols. This machine has done much to bridge the gap between the office duplicating and the printing field, but such apparatus is rather costly and requires more skill to operate satisfactorily than normal typewriters. The Varityper A.20, which is considerably cheaper than the D.S.J. machine, will give line justification but only unit spacing. A wide variety of type faces and symbols are also available for this model. Improvements have recently been incorporated in the D.S.J. machine, which is now classed as model 160.

As with all typewriters which justify by direct typing, it is necessary to type the line twice. The first typing will indicate the number of characters on the line and this figure is then set on the machine. The second typing automatically spaces out the characters and thereby justifies the line. This requirement restricts the output of the machine when justification is essential. To avoid this necessity to double-type by manual means, special apparatus known as the Justowriter is available which consists of two units called the Recorder and Reproducer. The Recorder is a composing machine with an

electrically powered typewriter keyboard which, in addition to typing a copy in the normal way, automatically produces a punched tape, complete with justification codes, for justifying the right-hand margin. This tape is inserted into the Reproducer, which interprets the tape and automatically produces, at 100 words a minute, a justified copy in page or galley form on a master for direct reproduction. It will therefore be seen that, although still requiring a double typing to provide a justified line, this machine is able to achieve this result by only one manual operation.

The Recorder can be supplied in a wide range of type-face styles, but only one style can be fitted to each machine. In practice it has been found that four or more Recorders can be employed with one Reproducer, since, regardless of the size or style of the type used on the Recorder, it can be used to produce justified copy on the Reproducer. Corrections and deletions are quite easily made on the tape, a special line delete enabling the whole of one line to be removed when not required.

The quality of the result given by these machines is ideal for reproduction and, since justification can be achieved without additional manual effort, they should do much to bring 'near print' to reproduction methods.

Known as the Flexiwriter, an adaptation of this machine can be used with punched card and electronic apparatus, in a wide variety of applications.

Recently introduced in France is a machine which is able to produce a justified line from an unjustified typed copy. Known as the Optype Line Justifying Machine, it provides a direct method of producing a justified film negative of the original unjustified copy by photographically reproducing each line separately.

In practice this machine subjects each line to a suitable optical method, which, without any counting or calculation, automatically justifies the line by a simple exposure which lengthens the short line and shortens the long line, without changing the height of the characters and without making it necessary to displace the document or film. The machine works at high speed, normally operating at about 720 lines per hour. On the basis of seventy letters per line it reproduces 50,000 letters per hour, or 170 words per minute, which is equivalent to twenty pages per hour. At this speed one single Optype Line Justifying Machine is capable of justifying the work of five typewriters.

The Optype line justifying machine has been fitted with a number of improvements which have led to the development of another model, known as the Optype Type-setting Machine. By means of

two operations this produces a positive film if required, justified and paginated. Its main features are that with special optical devices it not only justifies the original text, but produces variations in size when required. Starting with a single original fount of type, one thus has a series of sixty different types based on ten heights, three degrees of spacing and two styles, roman and italic.

The original size can be reduced continuously from fourteen to 6 point, with intermediate sizes in steps of a point or half-point. Transition from one size to another is automatic and does not involve any modification in the distance between the document and the film, and therefore requires no focusing adjustments.

Fig. 39.

Variation in spacing can also be made by an optical device which compensates for the difference in width of the typewriter and typographical founts. This compensator allows for three variations in spacing: namely, narrow, medium and broad styles. The difference in spacing allows 25 per cent more letters to be recorded in the narrow type of fount. The change of style is automatic, requiring no skill in adjustment.

Another device incorporated has the effect of setting the vertical lines at a slope while maintaining the horizontal in position. This gives an oblique copy of the original, approaching the italics style. The device is automatic in action and has the advantage of not altering the size of the original, and therefore does not affect the adjustment of the lines.

The Optype machine can also be fitted with a method which is able to cancel lines containing errors made in typing. This method enables words to be included in a given style without resorting to different masks. An electric device can also be incorporated for continuous exposure and reproduction of all kinds of documents, printed or drawn, and ruled forms, with maximum dimensions of 160 × 220 mm.

The two available models are described as a 'Justifier' and a 'Composer' and are already used in France for the office type of printing machine.

Phototype composing machines are also available. This apparatus is based on a new conception and uses photographic negatives containing a reproduction of the various type faces to be produced. Light penetrating this negative projects each character on to a photographic film or paper. After processing, the film is transferred to the proofing machine to produce the copy.

A number of these machines have been designed working on different principles and, when more widely available, they may be of value in reproduction work since they are able to provide a suitable negative for the preparation of the lithographic master. Such machines are, however, extremely costly and require skill to operate them. More simplified type-composing machines are also available which provide a photographic copy, generally in strip form. This is assembled in the required order and then photographed to provide a duplicating master. The Filmotype machine, designed specially for this type of work, is able to produce sharp, clear proofs from 12 to 144 points. It is operated in normal room lighting and type proofs can be made on film or paper. Over 250 type founts are available and justification of line is easily controlled.

The Typro portable composer is a table-top machine, of the typewriter size, which produces the copy on waterproof photographic paper. The machine is complete with automatic developer, requiring no dark-room and only a few minutes' training to operate. A wide choice of type faces from 10 to 144 point is available. The copy is produced by individually exposing the required letters which are then automatically developed and ejected in strip form, ready for use.

The Coxhead Liner is a machine which enables composing to be done merely by dialling. The machine operates on the photographic principle of making black-and-white transfers to paper. The complete fount is a negative disc, which is positioned on top of the machine. By moving the dial to the selected character, the type is printed photographically on a paper roll.

These machines can also be used to provide large headlines, frequently required on reports and similar covers. The copy produced by this apparatus is used to make a 'paste-up' master, which is then photographically copied to the same or to a different size. This method is more fully discussed in the chapter dealing with reproductions.

The development of all composing typewriters and other machines is designed to provide results comparable with letterpress, without the technical skill and expense now required in type composition. The end purpose of all duplicating efforts, whether we are printing a few or many, is to produce the best quality consistent with economy.

These special machines will do much to achieve this end, but they are expensive and slower in operation than ordinary typewriter methods; they are, however, usually cheaper than letterpress composition. Where the best-quality results are required from the duplicating processes, the selective use of these special composing machines is desirable.

CHAPTER XLVIII

THE PROCESS CAMERA

PHOTOGRAPHY is closely allied with reproduction methods. Where handbooks, reports or advertising matter are required, it can provide both the continuous tone illustrations and the line or half-tone negatives. It is also useful in making intermediate negatives or positives for transferring work from one process to another, to reduce or enlarge originals and prepare a suitable master for further reproduction.

Where such work is frequently required, the use of a large process camera is desirable, if not essential. The process type normally used in this class of work is bulky and expensive, but is admirably suited for photo-mechanical work. If such equipment is too expensive the use of cheaper and more simplified apparatus may be considered. Process cameras are now available which have been specially designed for office lithography. These are compact but are able to take negatives up to 20 × 16 in. They are restricted by the limited reductions they can give, but otherwise are capable of producing negatives of an extremely high standard. Simple apparatus of an upright form is available to give a limited enlargement and reduction.

Where such equipment may be found too expensive, or its use insufficient to justify the cost, adaptations can be made which will provide negatives of good quality. Cameras of the old, square bellows type, long discarded by the professional photographer, may often be purchased quite cheaply and adapted for this purpose. Fitted on a cradle and running in guide rails which allow it to be moved to and from the copy-holder, but always parallel with it, such apparatus will provide a most useful copying camera, able to meet many requirements in the reproduction department. The camera should be large enough to take a negative which can be printed direct on the largest offset plate used. One taking negatives up to 12 × 15 in. is suitable for plates 13 × 16 in. since the small margin given on the printing paper, because of the smaller size of the plate, is acceptable. The lights should be placed at about 40 degrees from the centre of

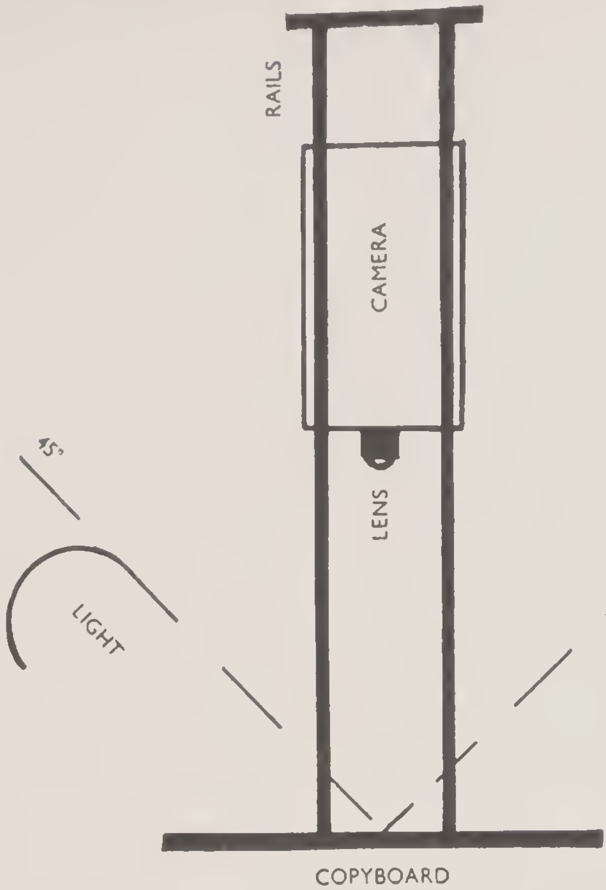


Fig. 40.

the copy to give even illumination. They should be housed in efficient reflectors to avoid light reflecting on the camera lens and they should not be less than about 500 watts each, to allow the exposure to be reasonably short with the slow emulsion material used in this work.

The double plate holders usually fitted to this type of apparatus can be made to take cut film if required. A discarded plate or a thin sheet of glass or metal can be treated with a special adhesive, sold by the film manufacturers. This will hold the film when it is gently pressed into contact with it. A slight adjustment to the focusing screen or to the film holder must be made to ensure that both are in absolute register with each other. This can be tested by a very simple gadget, which consists of a strip of wood into which a screw has been fitted in the centre.

To test for register, the back of the camera carrying the focusing screen is removed, and the strip of wood laid across its inner surface, the screw being turned until it just touches the ground glass. The plate

holder, containing an old film, is then inserted in the camera back, the slide sheath is withdrawn, and the testing apparatus again laid across the camera back. The camera back can be removed for this purpose. The position of the screw will indicate whether the register is accurate, and, if not, how much adjustment is required. If the ground glass has the matt side opposite to the point of the screw, it will be necessary to make allowance for this thickness or reverse the ground glass.

The copy-holder should be made of soft wood or fitted with a cork or lino mat, to enable drawing pins to be inserted to hold the copy. If the holder is fitted with hinges it can be laid flat, enabling the copy to be pinned down more easily. Care should be taken to ensure that when brought to a vertical position for copying it is absolutely parallel with the sensitive emulsion. Alternatively, a glass covered copy-holder could be used. If the lamps are placed as previously indicated, no reflection from the glass will occur.

This type of camera can also be made to work as a dark-room camera, thus extending its usefulness and increasing working speed. The back focusing arrangement allows it to be fitted into a hole in the dark-room wall, and to be made completely light-tight. The supports, both back and front, should be solidly built to avoid vibration.

The easel outside the dark-room must be made to run on tracks, and a simple system of using bicycle gear-wheels and chains can easily be devised for moving this from within the dark-room, to enable focusing to be done from the camera position. It is also usual with dark-room cameras to have means which enable the lens to be set at the correct aperture and the shutter operated from the dark-room. These are not difficult problems to a handyman, or particularly to departments which have access to works engineers. The usefulness of this camera is increased if at least two lenses are available, one for normal work and one of a shorter focal length to make negatives larger than the original being copied.

Another extremely useful device which can be seen in some reproduction sections is a dark-room camera made by merely inserting a suitable lens into the dark-room wall. This requires a short track within the dark-room, to carry a small holder for the negative material, and a longer one outside to which the copy-holder is fitted. By using bicycle gear-wheels and chains, these can be moved and the image brought into focus at the correct size. The film can be pinned to the easel or, by using the sticky solution previously described, it can be made to adhere readily in the required position.

By extending the rails and using a larger easel within the darkroom, this type of apparatus can be extremely useful for making direct paper or translucent reductions, to half-size or other reasonably large sizes, from dyelines, blueprints or other originals.

The 'Photostat' machine can also be used as a process camera, the pedestal model being particularly suitable, having accessories enabling it to be used for this purpose. The prism is normally removed from the lens to enable a direct negative to be made. Special paper is available for this work, but any of the thin, translucent type would be suitable. Holders to take any form of negative material can be fitted to the pedestal model and the available light positioned to give even illumination on the vertically arranged copy. The lens fitted to all 'Photostat' machines will give critical definition over the whole of the sensitive emulsion surface.

The 'Statfile' and Barcro apparatus can also be used as process cameras, within the limitations of the size of the sensitive material they are able to accommodate.

ESTIMATING EXPOSURE

The required exposure can readily be found by making a test strip or by using a photo-electric meter making the necessary calculations to allow for all the factors involved. It should be remembered that exposure time is governed not only by the amount of light available, but by the type of copy, lens aperture and the negative material being used. It is also considerably influenced by bellows extension, which governs the relative sizes of the copy and original. When making a copy of the same size as the original, the bellows will be extended to twice the focal length of the lens used and the effective aperture of the lens will only be one-quarter of that when the bellows is used at single extension.

A simple but effective method of estimating the required exposure when copying can easily be made with any camera. It is based on using different exposures according to the extension of the camera and a given lens aperture. To operate this method a tape rule, or preferably a retractable spring rule, is attached to the camera. This is used to measure the distance from the lens to the sensitive emulsion.

To determine the correct exposure times required, a copy is first focused to the same size and the lens diaphragm set to a given aperture. This should be the one which will normally be used, such as f/16 or f/32. The plate or film is then exposed in a series of steps, each receiving twice the time of the previous one. After development in the recommended solutions, for the correct time this is carefully

EXPOSURE TABLE FOR COPYING

Bellows Extension	*Process Film*	*Kodalith*	*Ilford*	*Process Pan*
8	5			
10	8			
12	12			
14	15			
16	20			
18	26			
20	33			
22	40			
24	47			
26	55			
28	63			
30	72			
32	80			
34	93			
36	105			
38	118			
40	130			
42	142			
44	155			
46	168			
48	—			
50	—			

examined to determine the most suitable exposure time for that original, at that stop and camera extension. A card should then be prepared, the left hand column reading from 10–50, and this is marked 'Bellows Extension'. Other columns should be included for inserting the exposure time, which will be placed opposite each figure of the bellows extension. The additional columns are necessary to record the time required for the different types of sensitive emulsions which may be used. If, therefore, the test indicated that an exposure of 80 sec. was required to produce a satisfactory negative, this figure should be placed opposite the figure indicating the bellows extension. With a lens of 16 in. focal length, this will be approximately 32 in. All other exposures at varying bellows extensions can then be readily calculated by a logarithmic scale. The following example will indicate this more clearly.

It will be seen that having once prepared the chart, any future exposure at any scale of reduction can be determined by focusing the image to the required size and measuring the bellows extension. The new exposure will be found opposite this figure; thus, at 20 in. extension about 33 sec. exposure will be required.

The lights must, of course, always be kept at the same distance and of the same intensity, and the same developer at a uniform temperature must be used. For those not familiar with photographic techniques, valuable technical information can be found in any issue of the *British Journal Photographic Almanac.*

For each type of sensitive emulsion used a further test exposure will be necessary, to determine the exposure time for that material. This should be recorded in a separate column. The test original in each case should be one of normal contrast. Other originals which are lighter in tone may be given half or a quarter the normal exposure, and darker copies an exposure of from two to four times the normal according to the tonal variation from that of the test original.

For those who prefer to maintain a constant exposure and lamp distance, it is necessary to vary the diameter of the lens aperture according to the bellows extension. A simple system can be arranged by dividing the lens apertures in thirty-seconds of an inch. First gum a strip of paper round the lens mount adjacent to the control ring. Unscrew the front lens component, to allow access to the diaphragm, and with dividers set this at 8/32 in. Mark the gummed strip in line with the arrow on the control ring as No. 8. Then set the diaphragm at 12/32 in., 16/32 in., and so on, up to its full aperture, marking the gummed strip at each setting, and sub-dividing each into four small sections, by hand. After the camera is focused to the correct size, measure the extension and divide the number of inches by two, to

give the stop value. Thus with a camera extension of 24 in., the stop on the gummed ring will be set at 12. With the same film, type of copy and light intensity, all variations in copy size will require the same exposure at the correct stop, as determined by the bellows extension.

With either of these last two proposed methods of working, the exposure is constant and the time is best determined by making a 'step test'. Expose a film at any scale (the lamp distance or stop size being set according to which of the two systems is to be used) and give a series of exposures of, for example, 15 sec. to the whole film, cover a portion by sliding in the sheath of the dark slide a short way and give another 15 sec., then cover another portion and give a further 30 sec., cover another portion and give 60 sec., cover again and give 2 min., so that the film will have received total exposures from 15 sec. to 4 min. Upon developing, the correct exposure will readily be apparent.

Designed for use in the preparation of half-tone negatives, the Kodak Graphic Arts Exposure Computer enables the correct exposure to be given to obtain negatives of good printing quality. Since the makers have issued a comprehensive free booklet on its use, it is considered superfluous to deal more fully with this computer here.

Other methods of determining the exposure are outlined in all books dealing with copying processes. These also deal fully with the use of filters and panchromatic materials when copying originals which contain colour.

The normal type of material used today in preparing masters for the lithographic process is known as 'lith'. It is able to give the extreme contrast necessary for this type of work. All photographic manufacturers of repute have a special graphic arts section, which deals exclusively with these materials and is able to advise or give instruction on their use. They issue numerous leaflets and periodicals which keep users aware of the many developments being made in this field and they should therefore be consulted in all matters relating to this class of work, unless a fully trained photographic operator is available.

In the chapter dealing with half-tone reproduction, it is explained that a special glass screen is required for this work. Process cameras are normally fitted with screen gear which enables this screen to be housed and moved by millimetre adjustments. Both the screen and the gear are expensive and require considerable skill to operate.

The growing use of the magenta or grey screen, sold by Kodak Ltd., has done much to reduce the skill required and also provide

good half-tone reproductions on the small offset machine. These are known as contact screens and are made of a thin, flexible material. In use, they are laid in contact with the plate or film and are held together in a suction frame. The exposure is made through the screen, contrast being controlled by two filters which are used on the camera lens, or by a white light exposure and a 'flash' exposure.

The magenta screen consists of a pattern of magenta transparent elements, which are graded in density on a flexible film base. The dots structure produced is irregular and the dots are not always circular.

The principal advantages claimed for this type of screen is that it gives increased detail sharpness and better tonal reproduction, resulting in improved quality in the final copy. Simple techniques for controlling contrast allow the maximum quality to be obtained from a wide range of subject-matter. Working methods are also simplified, and the technique is suitable for all types of cameras which can be fitted with the vacuum back necessary to hold the film during exposure.

A contact screen is also available, which allows a screen negative to be made by the use of a photographic enlarger. This may be useful when no copying camera is available, but access to an enlarger is possible. These film screens are considerably cheaper than the glass ruled type, but are liable to damage if not handled with care.

More recently, Kodak Ltd. have introduced a film which incorporates in the emulsion the screen required for half-tone work. This film is therefore quite independent of any screen and the necessary gear to hold it, thus simplifying half-tone negative making and allowing any copying camera to be used. It is therefore particularly suitable for those previously described. Known as the Kodalith Autoscreen film it is at present available in a ruling of 133 lines only, but the effect of other screen rulings can be obtained by the normal methods of enlarging. For example, the equivalent of a sixty-five-line ruling may be obtained by making a screen negative on this film to half size, and enlarging to the size required on a 'lith' ortho film. The Autoscreen film is able to give extremely good results, with a finer rendering of detail than is possible when a conventional screen is used. It is particularly suitable for the reproduction of pencil drawings or when exceptionally fine detail is essential.

There is a wide selection of literature available dealing with these and other screens. These booklets explain in detail how to use the materials to obtain the quality results they are able to produce. Those interested in graphic art materials should request that their names be added to the mailing lists of both Kodak and Ilford Ltd.,

who issue, at frequent intervals, periodicals dealing with this subject. These are excellently prepared and contain a wealth of valuable information, written by experts whose task it is to outline these products and keep users informed of new materials as they are introduced. Demonstrations on their use will always be given by the graphic arts section, as previously mentioned.

CHAPTER XLIX

ILLUSTRATIONS AND THEIR PREPARATION

A CAREFUL STUDY of the printed booklets, reports and other documents which are normally produced by duplicating methods, will indicate that frequently the illustrations are not of the highest quality. Such illustrations cannot, as a general rule, be expected to compare in quality with those produced by letterpress, gravure or the larger lithographic machines, but often the result could have been considerably improved by more careful or skilful preparation of the original, and more expert camera work and printing. In many instances, the work may be quite adequate for the purpose and additional expense in its preparation may not be justified. However, where better-quality work is required, the results can be considerably improved by greater attention to the essentials of good reproduction.

The illustrations used in booklets and other material produced by the duplicating processes can be briefly classified as Continuous (full) Tone, half-tone and line. A continuous-tone illustration is an ordinary photographic print which has been produced from a photographic negative, by contact or enlargement. This photograph will contain about thirty tones, ranging from the lightest to the darkest tone. When it is copied for reproduction by one of the ink processes a half-tone screen is used, which breaks the photographic image into a collection of dots varying in size. This is known as a half-tone negative and the inked copy which is finally produced from the half-tone plate is called a half-tone print. A line illustration is one from which all tone is absent. This may be a plan, drawing, sketch or similar matter. Drawings of this type can be modified by including artists' tints or shades, which give a representation of tone, but these are copied as line drawings and do not require the use of a half-tone screen.

CONTINUOUS TONE

The use of continuous-tone photographic prints for illustrating booklets or other duplicated material is expensive. Such illustrations

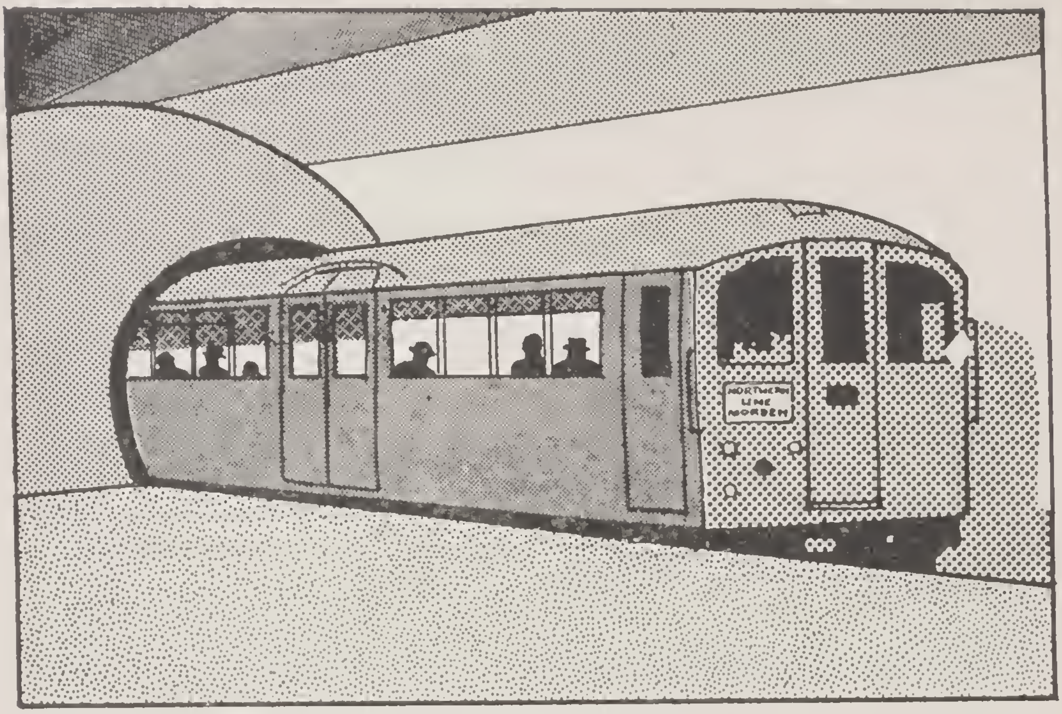


Fig. 41. Original drawing by Corbell, Cope Ltd. with Plastitone shading medium.

are therefore limited to publications produced in small numbers, or where the particular quality given by the photographic print is essential.

The economic limit in the use of photographic illustrations is a much-debated point. However, in view of the cost of preparing a print for half-tone copying and the subsequent time and labour involved in making the half-tone negative, and printing this down on to the offset plate, it may be reasonable to assume that up to about 50 copies would be cheaper to produce photographically.

The main objection to the use of photographic illustrations is that they increase the bulk of the final booklet, because of the thickness of the photographic paper which normally gives a print on one side of the paper only. This thickness is increased if small prints are pasted on paper of the size used in the book. By using air-mail photographic paper, which is extremely thin and pliable, this objection can be obviated. If printed or cut to the same size as the the book it will enable bulkiness to be reduced. A great advantage of using paper of this weight is that the book remains flexible and the pages lie flat when opened.

Where prints of a very high quality are not essential, the use of continuous-tone diazo paper may be satisfactory. The lower cost of this paper would allow it to be used for longer runs than would be

Fig. 42. The Peak District (Simplified Geology) showing the use of five tints.

Permission West Partners.

economic with photographic materials. The preparation of a good positive print on thin, translucent paper or film of a size suitable for contact printing is a simple operation. If printed on an automatic machine, production costs would be low and the quality of result constant.

Experiments made by using a magenta screen to produce half-tone copies on diazo paper have indicated the possibilities of this method. The screen used was a 133-line screen and this has produced prints of excellent quality; lay observers who have examined the results did not realize they were screened or that they were diazo copies.

The method employed is to make a film transparency from the existing negative, preferably through an enlarger, using film of a photo-mechanical type. The condenser type of enlarger should be used if possible and the negative placed in the carrier with the emulsion side towards the light source. This will give a reversed-

reading positive transparency, which can be printed in face contact with diazo paper.

After having focused the projected image to size, making allowances for the thickness of the film, the photo-mechanical film is placed emulsion face upwards and the magenta screen is then placed in contact with it. Variations in contrast can be made by the way in which the screen is used, more contrast being given when the screen is face uppermost and less contrast when the two emulsions are in face contact. To obtain contact between the two films a clean sheet of quarter-plate glass is laid over them. Printing frames may be used if preferred.

With the lens stop down to f/11 the exposure will be about 30–60 sec. Where some control is required shading or printing in may be employed during the exposure.

Although quite good results can be obtained by direct development in the solution recommended by the maker some control may be exercised by using a transparent dish over an illuminated base such as a safe light.

Development is continued until with the aid of a magnifier the finest dots can be seen. At this stage the darkest part should consist of large, clearly defined compact dots. These conditions produce a transparency of excellent contrast.

The original negative has some influence on the final result and one which is able to give a good print on a soft bromide paper is preferred. Where the negative is too soft and therefore does not produce a transparency of sufficient contrast the use of a rose filter such as Wratten 30 for either part or whole of the exposure will increase the contrast. Where the original negative may be too contrasty, the effect can be reduced by the use of a yellow filter such as a Wratten 5. By all these methods a flexible control can be maintained over exposure and development.

It will be appreciated that although diazo printing cannot compete with photographic printing for very small numbers or with half-tone lithography for long runs it is a useful method of producing 100 or even more copies where the facilities for making half-tone prints are not available. If these diazo prints are prepared on thin paper the same size as the book, they will save bulk and allow the report to be quite flexible.

Diazo paper of the vesicular type, which is able to produce a result almost equalling that of photographic paper, should also be suitable for continuous-tone reproduction. Being cheaper and more convenient to handle than silver halide paper, since it is used in daylight and requires no chemicals in the processing, it should do

much to enable short runs of continuous-tone prints to be made by direct methods.

HALF-TONES

As previously explained, half-tone illustrations are prepared by the use of a half-tone screen. A wide range of screens is available, varying from 55 line for coarse work to 400-line screens for high-quality printing. Those normally used in duplicating processes are of the 100, 120 and 133 lines per inch. The purpose of the screen is to break up the image into dots, varying in size according to the tone values of the copy. The same number of dots is contained in each square inch, but according to their size they create an illusion of tone by giving the impression of a black area where they are large and a series of grey tones when they are smaller. The effect can be readily seen by an examination, preferably with a magnifying glass, of any half-tone reproduction, particularly in a newspaper, where a coarse screen is used. The production of a satisfactory half-tone negative requires considerable skill. It necessitates two exposures, one for high light and one for shadow detail, together with a flash exposure to a white card or paper, to build up a solid core to the dot formation in the shadow detail. The more simplified methods of using the magenta screen or the Kodalith Auto-screen ortho film have been previously outlined.

Special stencils for making half-tone illustrations can also be prepared for use on stencil machines. They may be cut by an electronic machine or made through a special screen on photographic stencils, either by contact or optical methods. Both these means produce results which are reasonably satisfactory, but not of the same high quality as that given by photolithography.

RETOUCHING PRINTS

Half-tone prints produced by minor offset machines have a comparatively short tonal range. This is due to the relatively coarse screen used, and the lack of any additional control in the preparation of the printing plate. It is therefore common practice to modify the original print from which the half-tone negative is to be made. This is done by suppressing certain tones, particularly in originals having a long gradation scale with delicate tones which are similar to each other and in close proximity. This result, although falsified in the copy, is satisfactory in the final print. Technically, the purpose of retouching is to restore some of the tones which are lost when making the half-tone negative and copies.

Retouching of this type is normally done by process artists, using

an air brush and process paints, white and black. These are used directly or mixed to the correct tone and, by means of an air brush, are sprayed on to the photograph with a fine, even spray. To assist the artist where intricate detail requires retouching, special masking paper with slight adhesive qualities is available. This is laid over the photograph and the parts to be retouched are then uncovered by cutting round the area and peeling the masking paper away from the photograph. By this method, small details can be adequately masked while the broader areas receive the tone spray, or vice versa. Illustrations which are required to show modifications, or to give particular emphasis to certain parts, may be treated by this method and unwanted details can be 'ghosted' out by the air-brush technique.

LINE ILLUSTRATIONS

Line drawings are devoid of all tone. These may be prepared by the artist or draughtsman, and for reproduction purposes are copied directly, requiring no screen.

Half-tone screen effects can be created on line drawings by the use of tints or shading mediums. These are prepared on acetate sheets and are available in a wide variety of dots and other patterns. Some of these mediums are supplied with a slightly adhesive backing, which will stick to the drawing when applied to it. The tint is first cut to shape and 'let in' on the drawing. Another method is to lay the tint over the area and remove the screen pattern from the unwanted parts. When it is necessary to write on the acetate sheet, a drop of acetone added to the ink will make it adhere. Various effects can be achieved by superimposing two or more of these tints at various angles.

It can be readily appreciated that, in comparison with the manual preparation of such effects, the use of these shading mediums is extremely economical. A drawing prepared by their use is much improved, as will be seen by reference to any fashion or other advertising illustration in a daily paper or magazine. Such drawings are copied as line drawings.

When artists are not available to prepare line illustrations, some drawings can be prepared by methods requiring little skill or drawing ability. These, used in conjunction with shading mediums, can produce acceptable illustrations for reports, books of instruction or similar documents.

A method widely known and frequently used is the line-bleach system, in which a photographic print is outlined in indian or any waterproof ink; the photographic image being finally bleached away,

leaving a line drawing which is subsequently copied for reproduction. The outlining is done with a draughtsman's or mapping pen and the ink should be allowed to dry before the photograph is bleached away. Bleaching is made more rapid and outlining is easier if the print is under-developed in a weak metol developer. The flat image so obtained enables the outline of the design to be followed without difficulty and allows the bleaching solution to act quickly and efficiently, leaving no 'ghost' image.

Another method of achieving the same result is to blue-tone a fully exposed but under-developed photographic print. When this is outlined in Indian ink and copied by a blue sensitive 'ordinary' photographic plate, the blue will not be recorded. This method therefore avoids the necessity of bleaching out the photographic image and provides a suitable guide on which to draw.

A method which is also useful is to coat rag paper of good quality with ferro-prussiate (blueprint) sensitizer. A contact print is then produced and the image outlined with indian ink. The image is then bleached away in a 5 per cent solution of sodium carbonate.

Where an illustration is required to show partly as a line drawing and partly as half-tone, the photograph can be outlined in indian ink in the desired line portion and masked out, with a water-resisting paint or cellulose enamel, in the parts which are to remain in half-tone. The unmasked parts are then bleached away, after which the protective coating is removed by merely rubbing it off, when paint has been used or by amyl acetate when cellulose enamel has been used.

In recent years, scraper-board drawings based on photographs have been increasingly used to produce illustrations of unusual quality. Scraper board is a drawing material consisting of a white clay surface on a card base. It can also be obtained in a variety of 'dot' patterns or with a thin black covering surface. With this type of board, the 'whites' of the picture are created by scraping the black surface away as required. The result has an effect of woodcut, and can be photographed and reproduced as a line illustration.

There are various methods of getting an image on to the white-surfaced board. One practice is to make an ordinary print by one of the print-out processes, which will give the artist a visible picture on which to work, or to create an outline on the board by using a photographic enlarger to project an image from the negative to the required size on the board. This will provide an outline from which the artist can produce his drawing. This method can also be used to prepare illustrations on white paper or card. If the light parts of the projected image are filled in with pencil, a positive drawing will be

produced. By the use of various grades of pencil, including Conté, effective drawings can, with little skill, be readily created. It may also be possible to coat the scraper board with a sensitive emulsion, such as Emulsol. An image could then be created, by exposure and development, on the board and this used to assist the artist in his work.

A method which has been used successfully is to coat the white-surfaced scraper board with a layer of bright orange-coloured printing ink. A half-tone relief image is then made by the carbon process or wash-off relief film, rolled over with black ink and a proof pulled on the orange-covered scraper board. The artist then scrapes in his white areas and the result, copied on an 'ordinary' plate, will produce a suitable illustration for reproduction. This and other methods, together with some of those previously outlined, are described more fully by Frank H. Smith in his book, *Photographs and the Printer*.

A number of other methods are usable, most of which are probably too complicated for use in a reproduction section unless staff with photographic experience is available. The technique of Posterizing, now popular with pictorial photographers because of its repression of tonal values and the bold effects created, is effective for reproduction, but, since it requires the preparation of three additional negatives or positives, is rather expensive and difficult to do. These more complicated methods are useful, however, when something more attractive than an ordinary drawing or half-tone is required and artist's work is not available. The use of tints to create tone has been previously outlined. These are extremely useful, even with the bleach-out method, and can do much to improve any ordinary line illustration.

Special machines are also available which will prepare a pictorial sketch for illustration purposes from a plan or engineer's drawing. These machines are expensive and may be justified only where much work of this nature is required. Epidiascope projectors are also obtainable in many countries. This apparatus projects an image on to a ground glass screen, thereby enabling illustrations to be copied by tracing from the projected image. By using photographic means, drawings can be copied and reproduced same size, reduced or enlarged. By paste-up methods, new illustrations can be created which, when traced or photographically copied, are suitable for reproduction.

A special photographic method of preparing a line illustration from a photograph has been introduced by Messrs. Kodak Ltd. This is achieved by combining a positive film with the negative and it

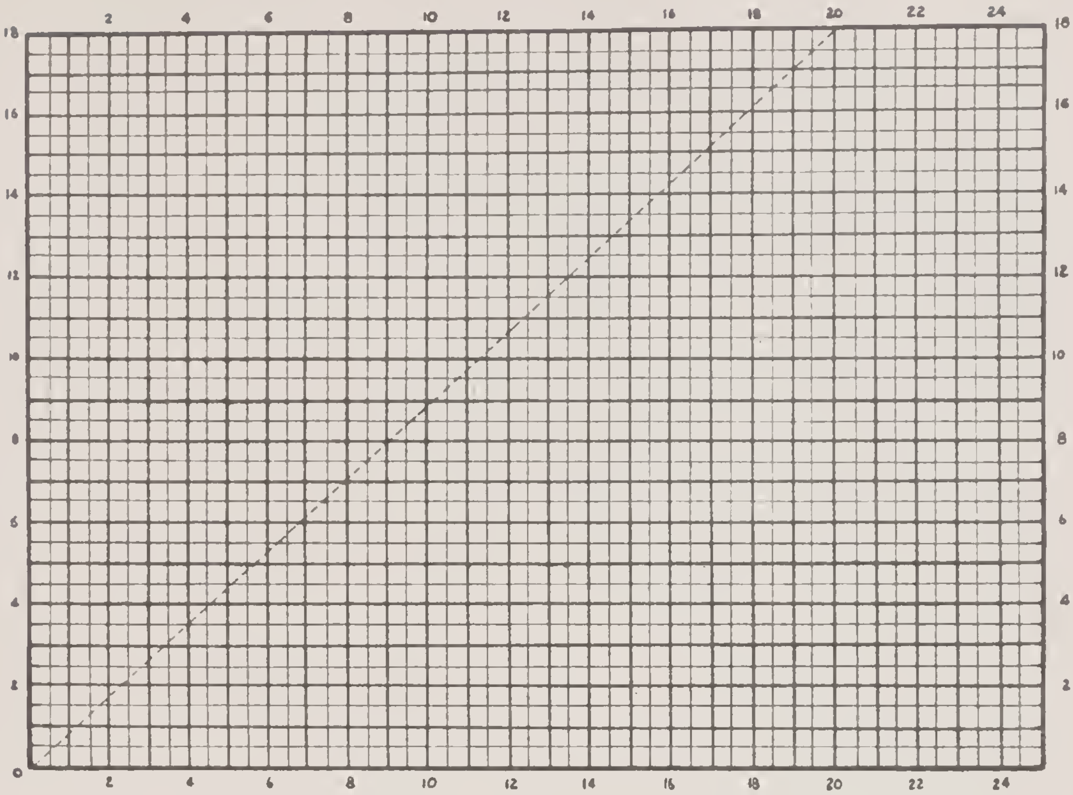


Fig. 43. Proportion Calculator. Place a ruler diagonally from '0' to the intersecting point of the two dimensions of the original. The area required of the reduced copy can be read from the known reduced dimension, e.g. 20 *in. by* 18 *in. to be reduced to* 5 *in. long will be* 4½ *in. wide.*

is claimed to be considerably cheaper than the normal method of line illustration. Results are extremely effective, but it would appear that some knowledge of photography may be required to operate the method successfully. For those interested, a small booklet called *Line Effects from Photographs by the Tone Line Process* is available, without charge, from Kodak Ltd.

LAYOUT PREPARATION

When original photographs or drawings are larger than the space allowed in the layout, the actual size after reduction can be readily ascertained, so that the correct amount of space can be allowed in the final mock-up. On the reverse side of the photograph or sketch, or by using a piece of tracing paper of the same size, a line is drawn diagonally from corner to corner. A vertical line is then drawn at the exact width of the column or area allocated to the photograph or drawing in the new layout. A line drawn through the intersection of the first two lines will give a rectangle which is the exact proportion of the area of the reduced photograph.

This will assist when using layout methods by indicating the correct area to be allocated when half-tone negatives have to be 'let into' the area.

In normal layout work of the line type, the paste-up method is particularly suitable. The tools required are simple and easy to use. They consist of a drawing board, T square and set square, scissors and paste or rubber cement. The guide lines should be ruled with a light blue pencil, which will not register on the camera negative.

The use of rubber cement for sticking the material on the card is perhaps preferable to paste, since it does not buckle the paper and excess cement can be readily removed when dry, leaving the copy clean and unmarked. However, the new type of paste, such as Polycell, is also satisfactory since this too allows the surplus paste to be removed from the photograph or drawing without damage. The choice of type-face styles and sizes and even the method of layout are matters of personal taste. Good layout can be achieved by training and experience, providing the staff have sufficient artistic ability to guide them.

Large letters can be created by special composing machines, such as the Headliner, Typro, etc. These machines create the letters on strips of photographic paper. They require no darkroom and are able to produce by simple operation a wide variety of type faces, sizes and styles, more than 100 different founts being available in some machines. The photographic strips are pasted into position to create the headlines. They can also be created manually by Uno, Wrico and similar stencils. The Sagenta Textograph is a useful device for the reproduction of script. The apparatus consists of a base plate, a grooved stencil which is able to slide laterally along the base plate and a writing arm fitted with a special pen. In use, the guide pen is moved around the grooves of the required figure or letter and this is reproduced on the drawing.

There are a number of paste-up aids available in some countries, Artype and Fototype, both American products, being particularly suitable. Artype consists of gummed acetate sheets, which are available in seventy-five different type faces, varying from 12 to 120 point. Fototype consists of alphabets printed on thin card and supplied in pads of individual letters, blue on one side and black on the other. These letters are detached from the pads and assembled in a special composing stick, with the blue letter uppermost. When the assembly is completed, a piece of Scotch tape is laid across to hold them in position. They are then removed from the composing stick and turned over, to give clean, black letters of the copy required.

Machines of the relief type can also be used, the large type face

available being particularly suitable for this purpose. When the type face is not sufficiently large, the copy produced can be enlarged by the Photostat or other photographic methods.

When corrections are made the paste-up technique is particularly suitable, since it is only necessary to cover the error with a correct letter, word or line. The extreme flexibility of the paste-up method is one of its main advantages. It allows full freedom of expression, since the whole layout can be corrected or modified as required.

The layout should be carefully planned and the position of all the pieces finally decided before they are stuck into place. The final test of the quality of a drawing is how it will reproduce. Not all drawings of good quality will reproduce well, and much will depend upon the reduction required. Some reduction may help to smooth out irregularities in the original drawing, but over-reduction may result in a loss of quality, if the original lines are too thin or the letters too small for good legibility when copied. The density of the line is also important. Indian ink which is applied without stirring may give a brownish colour, which will not reproduce well. All these factors are important and should be taken into consideration when the drawing is being prepared.

On completion, the layout is copied by a large camera to the size required. The negative produced will require opaqueing, to remove the outlines and other marks made by the paper. This is a simple operation, which should be done on a light box so that the outlines can be clearly seen and followed.

The negative is then printed by photolithography on to an offset plate. Alternatively it can be copied by the Xerox camera and a plate created by that method. When the stencil process is used, the paste-up can be copied on a photographic stencil by the use of the Photoscope apparatus as previously described.

CHAPTER L

COLOUR REPRODUCTION

THE USE of more than one colour with the ink duplicating processes adds much to the appeal of the finished product, but it considerably increases the cost of production. With the exception of Hectography, it is necessary with all the other methods to pass the copy through the machine once for each basic colour used in the final copy. There are, however, small machines available that are able to print more than one colour in a single run by the use of a tandem or dual head, but these are virtually two machines placed together, and therefore print consecutively and not simultaneously. Also, some machines are able to print the back and front of the copy simultaneously by using two printing masters, one above and one below the copy, but all these methods still require additional printing masters and colour runs to produce the final multi-coloured copy.

It will therefore be seen that considerable additional costs will be added to the final copy, because of the time required to make these repeated colour runs. Added expense and labour is also involved in creating the necessary colour masters, in cleaning the machine and obtaining the correct registration for each colour and in the increased paper wastage caused by all these factors.

For this reason, multi-coloured runs should never be made merely for decoration or effect. Their use should always be fully justified by the nature of the work and the necessity or the importance of colour in the final product.

The need for colour in reproduction can be frequently avoided by careful planning and the use of tints, shading mediums, cross hatchings and other aids. When the use of colour is essential, it is often possible to provide the illustration or sketch in a way which will enable the printing to be done economically. A sketch requiring three colours, e.g. black, red and blue, can be prepared by the artist on a strong translucent paper, using one sheet for each separate colour. When these are printed down by one of the well-known plate-making methods it would enable the three colours to be printed with the minimum of registration difficulties. A similar drawing on

a single opaque sheet would need three separate negatives, with each negative opaqued or blocked out, to provide only the one colour required in each printing.

The production of tonal colour illustrations necessitates the use of a large process camera equipped with a circular screen, which must be turned to change the angle according to the colour negative being made. Tricolour filters are also used in conjunction with panchromatic (colour sensitive) plates. The yellow printing negative is exposed through the blue filter, the red printing negative through the green filter and the blue printing negative through the red

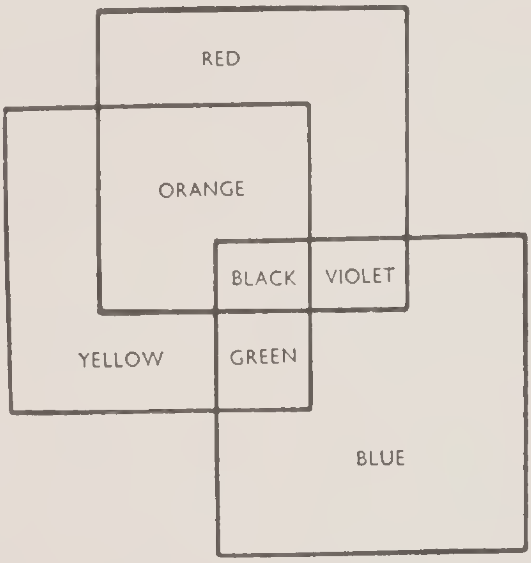


Fig. 44. Showing how the primary pigmentary colours (red, yellow, blue) combine to produce the secondary colours (orange, violet, green) and black.

filter. In addition, a black printing is added to give depth to the copy. In the final printing from the separations made with the red, green and blue filters colour reproduction (subject to the limitation of ink hues) can be obtained by printing respectively in cyan, magenta and yellow. The effect of this over-printing of colours is roughly illustrated by the drawing.

This type of negative making, and also the subsequent printing by offset lithography, requires considerable experience and should not be lightly undertaken in any reproduction section, unless the staff have the requisite skill.

SIMPLIFIED SYSTEM OF COLOUR PRINTING

A system for three-colour lithographic printing has been introduced by Eastman Kodak in the U.S.A. and a similar method has been developed by Kodak Ltd. in their research laboratories at Harrow. It may be described as a low-cost, short-run process and, although comparative cost figures are not available, it is considered that for runs up to 5,000 copies it would show greatly reduced costs against the more conventional methods of colour printing.

The system is based on the exclusive use of 35 mm. colour transparencies and is designed to produce a standard-sized print at the lowest possible cost. The final printing is done by a small office offset machine. The basic principles of this method are not new, but their adaptation in a simplified form enables small prints of an extremely good quality to be obtained with the minimum of technical skill. In a description given by Kodak Ltd., it is stated that the steps in the process are reduced to the following:

(1) A single mask to reduce contrast and to provide some colour correction is prepared from the transparency by contact exposure. A punch system is employed to register the mask.
(2) Direct half-tone separation negatives are shot through 'Kodak' Grey Contact Screens on to 'Kodalith' Pan Film. The film is pre-punched for register purposes.
(3) The negatives are automatically registered and printed on pre-sensitized lithographic plates.
(4) The plates are printed with special three-colour inks, again with the use of an automatic register method. Printing balance is controlled by densitometric measurement taken on the proof.

It will be seen that the principal features of this method are that all procedures are standardized and certain operations have been eliminated. Automatic registration is made at every stage and handwork on the negatives is avoided by masking. The offset inks have also been carefully selected for strength, gloss and hue characteristics.

The use of pre-sensitized plates is essential for this method and the 'Kodak' Lithofoil material is strongly recommended. Although any offset lithographic press can be used, the small office types such as Multilith and Rotaprint are especially suitable. Those used in the experiments were modified by fitting rollers and offset blankets made of 'Buna N' solvent-resistant rubber. This prevented the ink thickening, which would result in a loss of gloss and density. The final prints are made on a high-class coated art paper, producing copies of extreme brilliance.

Kodak Ltd. are not prepared to undertake colour printing by this method nor are they selling the system, but their expert staff are willing to advise and help on all aspects connected with it.

There has long been a need for a colour printing process which is economical for short-run work, particularly for scientific, medical, technical and similar journals. The beautiful results produced by this simplified method will undoubtedly meet a long-felt requirement in these fields.

CHAPTER LI

PAPER COLLATING, STITCHING AND BINDING

DUPLICATING MACHINES which generally print only single or double sheets create a volume of related material, which must finally be brought together to form a complete whole. This work is called collating, and may be defined as gathering sheets together and placing them in their correct order of sequence. The work is an essential part of the duplicating department. It is monotonous and absorbs an appreciable amount of time. For this reason, consideration should always be given to the problem to avoid the expense and delay frequently occasioned by the use of inefficient methods.

Collation may be undertaken by a wide variety of methods. Columns of duplicated paper may be set out on a table in their correct sequence and collated by walking round and removing the required sheet from each column. This method, whilst entirely satisfactory with girls of average ability, may be slowed down to the pace of the slowest worker. Placed on smaller tables, or in specially built pigeon-hole devices fitted in wooden boxes or on portable racks, consisting of metal trellis work having a number of divisions, the sections can be handled individually by the operator, allowing the more capable to work at a higher speed.

Columns of duplicated sheets may also be set out in a fan-like arrangement on a table. This will give the operator easy access to each sheet with the minimum of movement and enable the work to be done efficiently and with little fatigue.

There are a number of machines or devices available for collating duplicated material. Those designed especially for the printing field are large and expensive and therefore, with one exception, are considered to be beyond the scope of this book, since they are not normally suitable or are too expensive to operate with duplicating machines.

The revolving table system of collating has long been in use. In this method, the collating staff sit round an electrically rotated table

which contains columns of duplicated sheets. The top copy is removed by the operators as each column is rotated past them. This machine is also restricted by the slowest worker, since the table may be stopped by hand if necessary allowing the less capable to slow it to a required speed. It is also limited by the number of columns it can hold.

Small mechanical collators have been used in other countries for a considerable period. More recently, some of interesting design have been developed or introduced into this country. These machines will meet a long-felt requirement in small duplicating sections where they can be economically employed to hasten the collation of duplicated material and reduce the labour normally required for this work.

The *Thomas* collator is a treadle-operated machine having vertical stacks of trays, each equipped with a mechanical arm fitted with rubber tips. The arms rest on the stacks of paper in each tray and move forward when the treadle is depressed, thus bringing the top paper forward but not completely ejecting it. A brief examination is made by the operator to see that there are no double sheets in any tray and the paper is then gathered by both the left and the right hand. It has been found that, in general, a working rate of about 3,000 sheets per hour can be expected from this apparatus. When compared with the average manual method, this is a considerable increase in collating speed. An electrically operated model is also available which is able to give a considerably higher speed than the treadle-operated machine.

The Metromatic Paper gatherer is available in four models, having six, eight, twelve, sixteen stacks respectively. Small in size, it is particularly suitable for work where one or more duplicating machines are employed. The ingenious method used to withdraw the sheets from the stacks consists of a small belt of sponge rubber, about 3 in. wide and running between two rollers a few inches apart. These rollers are driven by a small electric motor, controlled by a foot switch. When this switch is depressed the belts revolve, bringing the top sheet of each stack forward.

The length of throw is easily controlled by the switch, but it is intended only for part ejection, since the sheets are gathered by hand from this position. Paper up to 10 in. wide can be collated by this apparatus.

The *Velodex* is a hand-operated machine, intended for use in small offices. The duplicated sheets are contained in six sections, an

arm fitted with a rubber pad resting on the front copy of each. Each stroke of a lever lifts these arms and raises the front sheet a few inches, allowing it to be gathered. The extremely low price of this apparatus precludes any automatic device but the design permits constant check to be made, so that blanks and double feeds are avoided. Light in weight, the machine can be folded and stored when not in use.

The Kuru Z.M. 55 is a German collating machine, but is available in many countries. It is designed to operate from six different positions, three on each side of the machine. The trays holding the paper are electrically moved across the top of the machine, and after passing underneath return to their original position.

Ten trays are fitted to the apparatus, these taking copies up to 12 × 18 in. Each tray can be divided into two sections, each taking sheets up to 9 × 12 in. A push-button stop-starter is attached to all collating positions, enabling each attendant to stop and start the machine when required.

A long, narrow table is available for fitting above the collating trays. This is intended to hold carbon paper, allowing carbon sets to be collected. Requiring a space of only 7 × 3 × 3 ft., the machine is compact and suitable for use in the office. It is claimed that each attendant can collate at speeds of about 3,000 sheets per hour, giving a total of 18,000 sheets when all the collating positions are being operated.

The Cummington Collator, which is suction fed, automatically gathers sets up to eight sheets at about 10,000 an hour. It can handle the lightest material from 5 × 7 to 11 × 14 in. It is claimed that the shuttle-type loaders on the apparatus operate without any waste of time and that the feed system is self-adjusting for any paper thickness.

The Macey Collator is a powerful, high-speed machine able to gather up to 64,000 sheets an hour. It is said that one semi-skilled operator can collate up to 24,000 sheets per hour, using the eight-station machine. Models are available having from four to sixteen trays, collating from sheet sizes ranging from 4 × 8 in. to 12 × 17 in., according to the model used. They can collate materials varying in thickness from thin paper to thick card. An automatic detector checks each collated set for thickness, and stops the machine when any variation occurs. The fault can be readily seen by the indicator lights, which are illuminated when the machine is stopped by this device. A number of attachments are available including stacking, jogging and stapling units. These enable the work to be quickly removed from the receiving tray unit.

Apparatus is also available which works on an entirely different principle from those previously described. Known as *The Reproduction Accra Feed*, this machine consists of a drum divided into fifty separate compartments. One identical pile of duplicated paper is contained in the paper feed, and as the drum revolves one sheet is fed automatically into each section of the drum. This procedure is repeated with stacks of each subsequent page until collation is completed. The collator is able to compile up to fifty identical sets of printed matter in one operation and each compartment can finally contain 125 different pages in proper sequence, ready for binding, stitching or stapling. It collects at speeds up to 6,000 sheets per hour and is fully automatic. Photo-electric scanners eliminate any unprinted pages, so that no blanks are gathered at any time. An adjustable micrometer rejects double sheets and an electronic system prevents the apparatus from missing a sheet. The machine is automatically stopped when collation is completed.

Vertical collators are also widely used in some countries. This type is extremely compact, requiring the minimum of floor space and, being mounted on castors, can be easily moved when not in use.

The J.C.M. is a fast and economical machine, able to handle work up to 11 × 14 in., and is available having four or eight sections. The machine is automatically stopped if a single sheet is missed or two identical sheets are picked up accidentally. This apparatus can be fitted with optical equipment which enables the collated sheets to be simultaneously stapled with one or two staples.

The Collamatic is a vertical collating machine, electrically driven and available in two models with eight and twelve trays respectively. The smaller model is able to hold over a ream of paper in each tray, but the larger one is limited to only half a ream. The sheets are brought forward by touching the starter switch operating the electric motor and are then collected by hand.

The machines are normally able to handle paper up to $8\frac{3}{4}$ × 14 in. but, by using the full width of the tray which reduces the number of sheets by half the small model can take up to 12 × 14 in. and the larger one up to 12 × $17\frac{3}{4}$ in.

The Collamatic can be used on a table when space is limited, or it can be supplied on a stand complete with a stapling and stacking table.

Where large quantities of collating have to be undertaken, the use of a mechanical conveyor type is particularly suitable. *The Motaveyor* is a machine normally designed for the printing field and consists

of a conveyor belt to which wooden cleats are attached to separate each set of sheets from the belt. The collating staff sit at intervals of two feet alongside the conveyor, each handling three sets of papers and place their sheets on the moving belt. On reaching the end, the completed set is removed, stapled if required and stacked. It will be seen that if the first operator places the last three sheets of a document in their correct sequence and each operator repeats this operation, the final collated stack will contain all sheets in their correct sequence.

The belt may be driven at speeds varying from 24–96 ft. per minute, and under normal production conditions has provided an output of approximately 4,000 per hour for each operator. This belt can be of any reasonable length, the small size being particularly suitable for use in the larger reproduction departments.

It is felt that manual methods of collating may continue to be used, owing to the variety of work undertaken by office printing machines and the small size of many duplicating sections. The simpler forms of collating apparatus as previously described, should, however, increase the speed and reduce the fatigue given by manual methods. Whilst it is evident that the greatest hope of achieving real saving in time, would be by complete mechanization, such elaborate and expensive apparatus could only be justified by departments producing extremely large outputs.

STITCHING AND BINDING

Duplicated sheets which have been collated in their correct sequence will need to be held together by stapling, stitching, gumming or in some other manner. A few sheets may be conveniently stapled in the left-hand corner, but bulkier documents will require more elaborate binding methods.

The side stitch is very convenient, allowing the paper to be printed singly and in correct order. A disadvantage of this method, however, is that it does not allow the book to lie flat when opened. With thin booklets this may not be a serious objection, but thick books, particularly those used for reference purposes, are better either spiral bound or saddle-stitched. In the latter method, the stapling is placed in the centre of a sheet, which contains two pages on each side. This method requires a little care and thought before printing, since the pages contained on each sheet will not be in correct order. The first sheet will contain, on the left-hand side, the first and second pages, and, on the right-hand side, the last two pages of the book. Each subsequent sheet, working toward the centre, will also contain the first two and the last two remaining pages. Thus, in a twenty-page

saddle-stitched booklet the second sheet would contain pages three and four on the back and front of the left-hand side, and pages seventeen and eighteen on the front and back of the right-hand side. In this manner, the pages will be built up, the central sheet containing pages nine and ten and eleven and twelve.

Where small pages are being printed, it may well be that, as in professional printing, a number of these will be contained on one large sheet. This can be appreciated by folding a sheet of paper. A single fold will provide four pages, a second fold will give eight pages and a third fold will produce sixteen pages. If this is to be stitched from the centre and then guillotined to provide sixteen separate pages, it will be found by numbering the folded sheet in the correct sequence that the inner face contains pages 14/3/2/15 and 11/6/7/10. The reverse side contains pages 12/5/8/9 and 13/4/1/16. On each sheet it will be noticed that the top of the page is towards the centre of the sheet to enable it to be correctly placed when folded and trimmed. The position of the pages will naturally vary according to the way the paper is folded. For this reason, it is essential that when folding machines are employed the pages should be arranged to suit the working method of the machine used.

The more elaborate and better class method of hand stitching is not generally used with duplicated documents. Those who require to do this work on special occasions will find listed in the Bibliography books and articles dealing with this subject.

A wide range of stitching and stapling apparatus is available. In general, it will be found that the small stapler, designed for office use, will not be of sufficient strength to withstand the hard wear necessary in a busy reproduction centre. Spring- or treadle-operated machines are generally more robust in build, and therefore better suited for general work, when the electrically driven apparatus cannot be justified.

CHAPTER LII

SPECIALIZED APPARATUS AND METHODS

IN ADDITION to the normal machines designed for general copying or reproduction purposes, apparatus or methods are available which have been especially designed to meet a particular or specific purpose. The following brief description outlines some of the more important in this range.

The Tickopress machine is especially designed for printing and overprinting small labels, tickets, tags and similar material. It is a letterpress machine, using type of various sizes, which is fitted in segments on a rotary cylinder. These machines can also print card and fabrics, such as satin or rubberized satin, cotton and also flat cartons, box ends and similar matter. The apparatus is available both manually and electrically operated and produces work of good quality in the specialized field it is designed to serve.

IMPRINTING MACHINES

For imprinting designs, lettering, trade marks and other forms of decoration and also display matter, two machines are available. These will produce lettering from special metal type, metal or cardboard dies and zincos on any material, including wood, in one or more colours by a dry colour process.

The Masson Seeley is able to operate either as a hot or cold process. The hot process is operated by means of an electrically heated pressure platen, using phosphor bronze dies or type and a special foil. This model marks metal, plastic, wood, glass, rubber, cardboard, silk and other fabrics, labels, instruction plates, together with showcards for general display work. By using coloured gummed paper with cutting dies, the cold process produces cut-outs in attractive colours.

The Markmaster is a similar machine which will also reproduce effectively on the same wide range of materials, including leather, plastics, celluloid, Cellophane and textiles.

Both these machines are simple to operate and will produce good results, quickly and economically. They are, however, expensive.

FLEXOPRINT AND VARIMASTER

Methods are available which have been designed to facilitate the reproduction of lists, index records, telephone directories and similar material which is being frequently amended and reprinted.

Flexoprint consists of an aluminium panel into which small cards are inserted. These panels are supplied in two basic types, holding either a single or a double row of cards. The cards are typed, preferably in an electric typewriter for even impression, and fitted with a carbon ribbon and a small device to hold the card in position. Inserted easily and quickly into the panel, the typed cards present a neat and orderly appearance. When the whole panel is photographed on process material, plate, film or paper, the negative can be used to prepare an offset plate for reproduction. The design and the quality of the cards allow the lines between each to be readily lost by normal lighting, and therefore provide a reproduction of good quality.

Corrections are made by removing the old card and replacing a new one. Additions and subtractions are also quickly made by inserting the additional cards in the appropriate place and by removing the cards which have become obsolete.

Illustrative booklets, outlining the methods used in the preparation of the cards and subsequent reproduction by offset lithography, are obtainable from the suppliers.

The Acme Photo panel is similar to the Flexoprint, being also designed for price lists, part lists, directories, indexes, etc. The panel cards can be typed by any typewriter. The panels are constructed of aluminium, various sizes being available. The cards are inserted into these and are photographed for printing on to offset plates.

The Varimaster has been designed to meet a similar requirement, but consists of a transparent panel of plastic material into which transparent strips are inserted after being typed. The particular advantage of this method is that it allows reproduction to be made by any dyeline copier, thus providing one or a few copies quickly and economically. Where a large number of copies are required, the panels can be copied photographically and printed by offset.

The panel is normally 13 × 8 in., but other sizes are available. The translucent slips are supplied in scored sheets and, after being typed, these are easily broken into strips for insertion in the panel.

When constant amendment is being made to any form or list, record or other variable documents, these methods offer a suitable solution and allow reproduction to be made by the most economical means.

CHAPTER LIII

ANCILLARY APPARATUS

IN ADDITION to the normal duplicating or photocopying equipment, a reproduction section will require some ancillary apparatus. The type of apparatus, and therefore the size of it, will depend on the amount of work it will be expected to do. Most of this ancillary apparatus is available in a range able to meet all requirements. In the case of departments where it is considered that the amount of work done does not justify some of this apparatus, certain printers or specialist firms are prepared to undertake this type of work at reasonable charges.

The following are some machines which are in general use. The classified index will give the names and addresses of firms who supply the apparatus.

GUILLOTINES

Guillotines are necessary to cut sheets into required sizes. They are frequently employed to trim the edges of stapled material, to give a neat and professional appearance. They are obtainable in a wide range, from small, lever-operated machines to large, power-driven apparatus, especially designed for the printing processes.

STAPLING, WIRE STITCHING

A wide variety of this equipment is available, to meet every purpose. It ranges from the very simple, hand-operated type, designed only for a few sheets, to spring-operated models, able to stitch or staple small booklets, and finally to those which are power operated and able to stitch up to 1 in. in thickness. These machines can be divided broadly into two classes, (*a*) those which use ready-made staples and, (*b*) those which make their own staple or stitch from a reel of wire or metal tape.

BINDING

To hide the unsightly appearance given by staples when duplicated books are side stitched, it is common practice to bind the rear edge and sides with gummed tape. This operation, which necessitates

cutting the tape into strips and gumming, followed by three further operations to complete both sides and the back of the volume, is time wasting and therefore expensive. Small machines which are able to do this in a single operation can quickly repay their cost where this type of work is required.

A small machine known as a 'back stripper' is available for this work. It was originally designed for the small printing office, but is a most useful machine for binding duplicated material. The gummed strip is contained in roll form in the machine and, in operation, the back of the book is placed in the holder, pressed into position, the strip being cut by the guillotine provided. It will work with paper, plastic or fabric strips and will handle books with spine widths varying from $\frac{1}{8}$ to $1\frac{1}{4}$ in. thick. Easy to operate, it will, with little practice, produce up to 300 bound books per hour.

FOLDING

Folding by hand is a slow operation and therefore expensive, with present-day high labour costs. Machines are available, both simple, hand-operated and power-driven models, which are able to work at high speeds, producing a number of different folds, both simple and complicated. These not only expedite all folding operations but also eliminate the dull, monotonous task and release personnel for more important work. They also provide a neater and more accurate fold, particularly useful when correct alignment is essential for over-printing or inserting into window envelopes.

PERFORATING AND PUNCHING

This type of apparatus is occasionally required, but in small departments the amount of work may not justify its installation. Such work can be done by any printer or trade house, but machines are available for it if required.

NUMBERING

Some form of numbering device is occasionally required and machines can be purchased from a restricted range. A number of duplicating machines can be fitted with numbering attachments, to perform this operation when copies are being printed.

GUMMING OR GLUING

Machines for this operation are occasionally required. They are available for use with professional printing machines in a fairly wide range, but normally these are not suitable for the more restricted

requirements of document reproduction. A few machines are, however, available which are small in size yet efficient in operation.

SHREDDING

These machines enable old records, particularly those of a confidential nature, to be completely destroyed in the security of the office. They are therefore a useful adjunct to the reproduction section where confidential papers are being duplicated or copied, since they enable all spare or waste copies to be completely destroyed.

The machines contain numerous rotating blades which shred the paper into narrow strips, so that no letter or word can be read. The shredded paper which is left becomes a useful by-product, suitable for packing purposes or to be sold as waste paper.

This apparatus is quite small and suitable for office use. The output varies from about 50–80 lb. per hour, the sheets being fed loosely into the throat of the machine. Rapid and clean in action, this apparatus is quite safe to use and requires no skill to operate.

SEALING

Dispatching duplicated materials is a necessary function in all reproduction sections. Work which has been printed with care deserves to be dispatched safely packed and sealed. For this purpose a number of machines are available, both hand and electrically operated.

Some of these machines are made for high-speed sealing, and can be obtained for both manual and mechanical operation, suitable for small or large parcels.

CHAPTER LIV

SILVER RECOVERY AND FIXER REGENERATION

IT IS NOT generally appreciated that the black image on a photographic document consists of metallic silver. Since the whole surface of the paper was originally coated with this metal, the unwanted silver being removed by the fixing salts, it is obvious that the fixing bath must contain a considerable amount of silver material. Large-scale users of photographic materials may therefore find it profitable to recover silver from the exhausted fixing bath, particularly so since this not only reclaims a most valuable metal, but in addition, regenerates the hypo bath making it usable over long periods. Fixing baths from which the silver has been removed may, with the addition of a small quantity of hypo, be re-used over long periods, thus effecting a double economy.

The following are some of the means which may be used for silver recovery.

(1) Chemical method (sludging).
(2) Electrolytic methods.
(3) Galvanic.
(4) Other methods.

The electrolytic and galvanic methods are perhaps the easiest to operate, the others being more complex and not generally suitable for the small user.

The chemical method consists of adding sulphide, which precipitates the silver in the form of sludge. The hypo is then drained off and the sludge placed in containers. The main disadvantage of this method is that the fumes are extremely dangerous to photographic material and therefore the operation must be done well away from any sensitive material.

One of the best known of the electrolytic methods is the Purhypo. This equipment is installed by the firm free of charge and, by agreement, a percentage of the recovered silver is retained as payment for this service.

The Purhypo apparatus is placed in a tank into which the hypo is circulated. The silver is automatically attracted to the plates of this apparatus and these are removed at intervals, the silver being scraped off before they are replaced.

This method is more suitable for departments where the hypo can be piped to a large tank for recovery. The firm of D. Pennillier, of Hatton Garden, who operate this system, will advise on the quantity suitable for its use.

Small units of the galvanic type are available, which are placed in the fixing bath. One of these, the Argeco, sold by Collinridge, of Riverside Road, Watford, consists of a sheet of metal to which are added cells enclosed in a plastic shell. The silver is attracted to the plates and these therefore must be changed occasionally, since they become inactive by continued use. This type is particularly suitable for a small unit, or where darkrooms are so placed that the hypo cannot be circulated to a common tank.

The Baker Platinum Electrolytic Silver Recovery Unit is suitable for use in darkrooms where the fixing solution handles from 100–1,200 feet of film or paper per week. It requires an a.c. supply and a tank of at least 10 gallons capacity, which must not be less than 20 in. deep and 12½ in. wide. The unit is very small and works continuously, without interfering with the normal fixing process.

Ilford Ltd. have recently introduced both a silver recovery unit and also a silver estimator. The recovery unit employs the electrolysis method and is designed to give a high degree of agitation while recovery is taking place. The cathode is in the shape of a spiral blade which is revolved by an electric motor and is easily removable for collection of the silver deposit.

The Estimator is an accessory designed to give an accurate indication of the silver concentration of the fixing bath. This outfit is supplied complete with all solutions for carrying out a large number of estimation tests.

Where these methods may not be desirable, a number of silver refiners are prepared to supply containers into which the discarded hypo is placed. These are collected by the firm, who replace the barrels with empty ones and return a percentage of the cost of the recovered silver.

Recovery of silver from discarded negatives and prints is also profitable, the silver refiners doing this work and sharing the profits. Any photographic manufacturer will supply a list of names of both the suitable apparatus and the addresses of the silver refiners.

CHAPTER LV

STORES AND STORAGE

THE STORE ROOM

THE STORE ROOM, which is essential to all reproduction departments, should be situated as near the duplicating room as possible to avoid any unnecessary work in carrying materials. It should be fitted with adequate racking facilities, either wood or metal, having divisions to enable separate items to be stored in these sections. These should be clearly labelled to avoid other materials being accidentally stored in them. If bulky goods are placed in the lower racks, it will reduce the heavy work to a minimum.

Good lighting is essential and provision should be made for the use of portable lights on wandering leads, or torch lamps, particularly where the racks are well recessed and therefore poorly illuminated. For this reason, also, the walls of the store should be of a light colour to give good reflection.

Where concrete or the bitumastic type of floor is used, it should be treated with one of the many proprietary liquids to prevent dust. Heating and ventilation are also important and variations in temperature should be avoided if possible. Photographic and other sensitive materials should be stored in the coolest part of the store and never near radiators, hot pipes or gas appliances.

To avoid the misuse of stores, and especially to maintain the stock at a reasonable level, it is essential that access to the stores should be limited to the storekeeper or other responsible persons.

CONTROL OF STORES

The inconvenience caused when stores are unexpectedly exhausted makes some system of stock control essential. Numerous methods are available, ranging from the normal stock record cards to the proprietary apparatus designed for production and other control systems which, owing to their flexibility, can be used also for storekeeping records, giving a day-to-day picture of the stock position.

From a superficial examination of the Vidento it would appear

that this method could be adapted for use with this work. In common with all these methods, the chart is designed to present facts visually. Here it is achieved by an unusual method of using sixty-two indicating columns into which fall tiny, precision balls. These balls can be added or removed from the column by button control, and a 'reservoir', holding 16,000 balls, is situated at the top of the columns. To identify each column a visible index is available at the bottom of the board and the whole face is covered with flexiglass, which can be written on with coloured crayons.

The Movigraph is a control system based on interchangeable signals, letters and numbers and a perforated panel. It is stated to be particularly suitable for stock control since it occupies only limited wall space and is quick and easy to operate.

The Roneo Visual chart is a combination of coloured signals, arranged to provide at a glance all vital facts and data related to one another.

The Remington Rand Graphdex is a versatile charting medium with special signalling combinations which can be used to control store problems.

The simple method of using stock cards will, however, be satisfactory for the small reproduction sections. A separate card should be maintained for each item of stock and this should be clearly classified to avoid confusion and error. A card of about 8 × 10 in. will be found quite convenient, providing speedy reference and flexibility of operation with economy of space. In very large reproduction divisions, where the stock change-over is of considerable proportions, a different system may be essential.

In a small section, where stock change is infrequent, a well-racked store with separate compartments could be used for the visible control of the stock, requiring only an occasional check.

Store control is an essential part within the organization of reproduction work. Its efficiency should be considered as important as that of the other processes, which rely on organized store methods to keep them adequately supplied with materials.

PAPER STORAGE

Paper for reproduction purposes is usually supplied direct by the manufacturers or from the machine suppliers. Under normal conditions this paper will be of good quality, having been especially prepared for the particular process for which it is supplied. It is, however, important to remember that good paper can be easily damaged by poor storage conditions and will give considerable

trouble during printing if it has not been allowed to mature sufficiently. During its manufacture, paper is subjected to numerous strains and stresses and it is therefore desirable to permit it to relax and mature for a few weeks before being used on the duplicating machines.

The storage conditions are, therefore, of some importance. Top floors have the advantage of good light and dryness, but in old buildings leaky roofs, skylights and window-frames can easily damage stock in adverse weather conditions. Storage below ground is to be avoided if possible. On the other hand, the paper should not be subjected to any form of excessive heat as, for instance, by being stacked close to steam pipes or radiators. Where possible, the paper should be stacked off the floor on stillages or in racks. Stacking directly on to concrete or similar types of flooring should be avoided. The racks used should not be of the skeleton type, because these permit the paper to sag between the laths and cause irreparable damage. Strong card or other cheap material can be employed when the expense of covering the base of such racks is a consideration.

The store room should be free from damp or moisture, otherwise the paper will tend to expand and, in consequence, develop cockling, waviness at the edges and curling. Damp of any kind should, therefore, always be avoided. It is the greatest enemy of all classes of paper and its presence can cause serious delays, particularly when fine registration work is required.

Where possible the paper store should be so heated and ventilated that its atmospheric condition, as regards both temperature and relative humidity, approximates to that of the room in which the paper is going to be used. Ideally, the temperature should be 60° to 65° F. and the relative humidity 65 per cent.

A paper stock-room run in an orderly and systematic manner is essential to a well-organized department. It enables stores to be kept at a reasonable level and allows the correct amount of paper to be issued with each order, thus avoiding waste and misuse.

CHAPTER LVI

THE STORAGE OF REPRODUCTION MASTERS

THE PROBLEM of storing reproduction masters has received comparatively little attention until recent years. This may have been due to the ease by which a simple rack could be erected and also to its cheapness in comparison with the few proprietary filing methods which were available for this purpose. Within recent years, a number of filing systems have been introduced which are able to accommodate all forms of reproduction intermediates, and there can be little doubt that, where many of these are stored and frequently re-used, these systems lengthen the serviceable life of the reproduction master and promote an orderliness in the storing of this valuable material. The efficiency given by a well-designed method and the ease with which such masters can be filed, speedily found and withdrawn when required, provides an economy both in time and labour.

The various systems available differ widely in the methods they use. For many years filing systems were designed to store the masters in a horizontal position, but more recently suspended systems, which store vertically, have become popular. Some of these may be housed in an ordinary filing cabinet but generally they are intended to fit into special cabinets, which are designed according to the suspension system used.

For use with the Hectographic process special filing pockets and master checking folders are available and these are filed in any ordinary correspondence tray, in a vertical position. Small cabinets are also obtainable with shallow drawers, enabling the masters to be filed in a horizontal position. It is generally agreed that vertical filing, which avoids placing additional weight on these masters, is greatly to be preferred.

A number of methods for storing stencils are also available. These are designed to protect them from dust, their greatest enemy, since this will destroy the stencils by creating holes when they are placed under pressure on the printing machine.

The Gestetner method uses a folder which is designed to blot and

hold the inked stencil. For identification, the folder is run through the stencil machine, taking an impression of the stencil to be filed. These folders are protected by being stored in a flat position, in a steel container. Storage folders and boxes are also sold by Roneo, Ltd. In this method, the folder is stored in a steel holder, on its edge, tabs being supplied for indexing the stencils.

Two important suspended systems which have been specially developed for this purpose are the Railex and the Eltray. The Railex filing system is designed to use a pocket, which is hung like a coat hanger on a rail. Removal or insertion of this hanger is a simple one-hand operation, the whole filing pocket being completely removed from the rack. A wide variety of different types and sizes of pockets are available, ranging from 8 × 3 to 40 × 30 in. Special holders to contain a single or a few stencils are available and also pockets to hold up to thirty stencils.

The Eltray system is a unique method of storing stencils, in which they are rolled in a translucent ink-proof wrapper on a separate frame. This allows the drawers of the cabinet to be kept to a minimum depth. The cabinets are available in single, six-drawer or other models, each drawer holding twenty-five stencils.

Another method using the suspension filing system has been introduced by the Stencil Filing Co. Available in two types, known as A and B, the cabinets are fitted with rust-proof hanger bars which also contain a title bar, to enable speedy selection of the required master.

Model A is a filing cabinet, $38\frac{1}{4}$ high × $15\frac{1}{4}$ wide × 24 in. deep. It is fitted with a lifting lid, hinged to give access to the deep compartment which contains the suspension rails holding seventy-two stencil hangers and accommodating 270 stencils. A drawer below is intended for holding ink and other consumables.

Model B is a two-drawer cabinet 52 high, 12 wide × $24\frac{1}{4}$ in. deep. The drawers will hold 144 stencil hangers or 570 stencils when the cabinet is fully stored.

For masters used in offset lithography, the suspended systems are particularly suitable. Most of these are able to accommodate both paper and metal plates. Pockets specially designed to hold plates of all sizes, up to $15\frac{1}{2}$ × 20 in. are included in this range. Each pocket carries its own identification tab and additional colour tabs are available. The cabinets which hold the suspended files can be fitted with roller blinds or folding doors, and when placed close to the wall require a minimum of floor space.

Methods of storing drawing office masters may be broadly classified

into two main types, viz. vertical and horizontal. Both of these are available in many forms.

The essential features which are necessary to provide a good filing system of this type are:

(1) Ease of operation.
(2) Rapid and accurate filing and extraction of the drawing.
(3) Maximum protection of the drawing.
(4) Space saving.
(5) Flexibility.

The vertical types meet most of these requirements but they do not conserve space, nor are they very flexible.

The steel and wooden drawer cabinets, which have long been used for this purpose, are space saving but are otherwise not entirely satisfactory. It is difficult to remove the lower drawings from these without damage; a weakness which can be partially corrected by inserting drawings into folders, using five or six folders for each drawer. Those having shallow drawers are preferable, since, by limiting the drawings contained in each drawer to 100, they allow a more speedy and accurate filing and extraction. A twenty-drawer cabinet, standing about 3 ft. high, provides a storage capacity for 2,000 full-size drawings, which is economical in space.

The more recent introductions to this field enable these masters to be stored horizontally in roll form. The Bristol Plan File Unit is of this type. It consists of an outer metal case, having the interior divided with a number of square channels into which the rolled drawing is inserted. A small, swivel index tab, fitted to the front of the tube, contains the drawing number and this is reversed when the drawing is withdrawn from the file. Extension units are available, enabling the cabinet to hold drawings up to 48 in. deep.

The Roller File Plan Filing Unit is also designed to file drawings in roll form. Each unit contains 120 tubes, into which a number of drawings, large or small, can be inserted. This cabinet is fitted with damp-proof and fire-resisting doors.

The Plan Store consists of a number of compartments, each housing a rectangular plastic socket. Drawings are rolled and one end is inserted into the socket, which is shaped to grip the roll firmly. The other end is then placed in the compartment and the socket is pushed firmly home. When the drawing is removed, a location slip may be substituted to indicate that the master is in use.

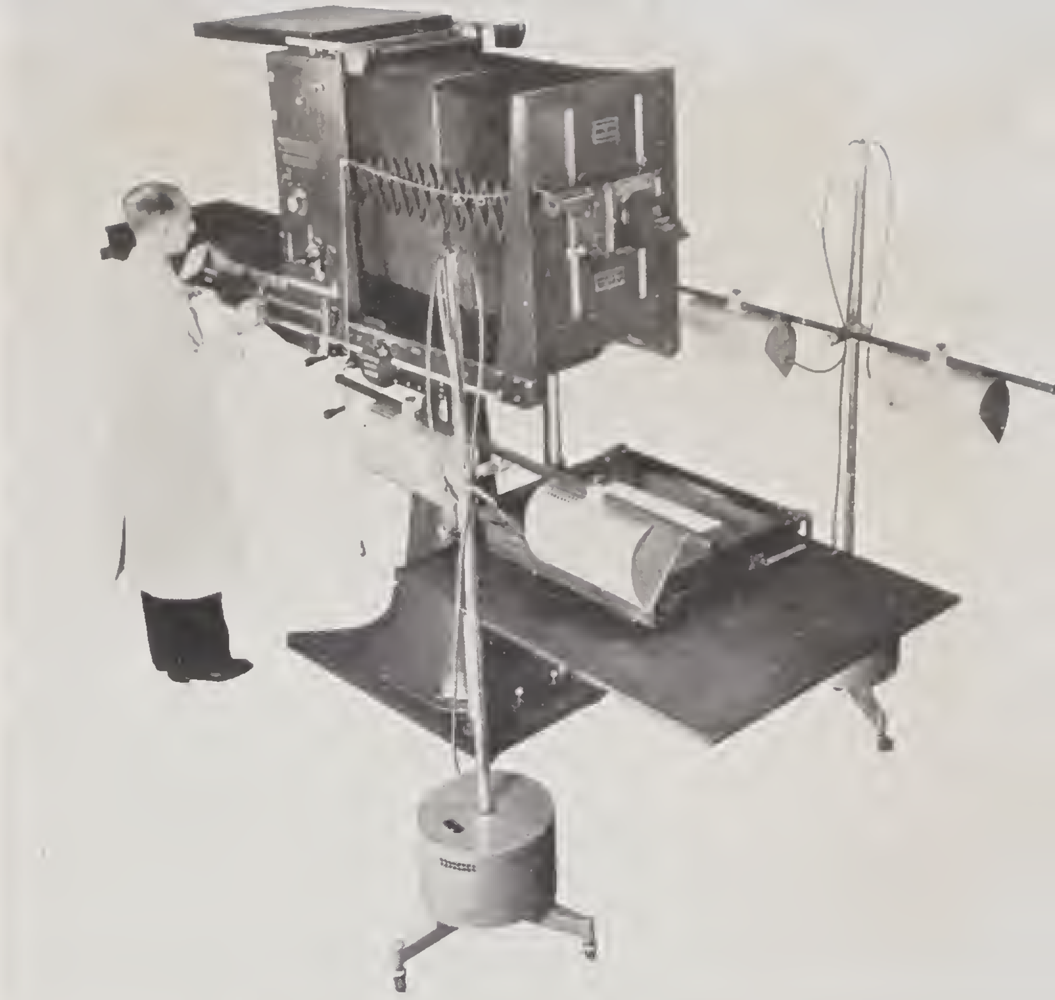
The Post Grip vertical plan file is a method consisting of a horizontal bar, held by two hangers. The bar is fitted with two clips,

which give a positive security to drawings, enabling the complete assembly to be suspended together.

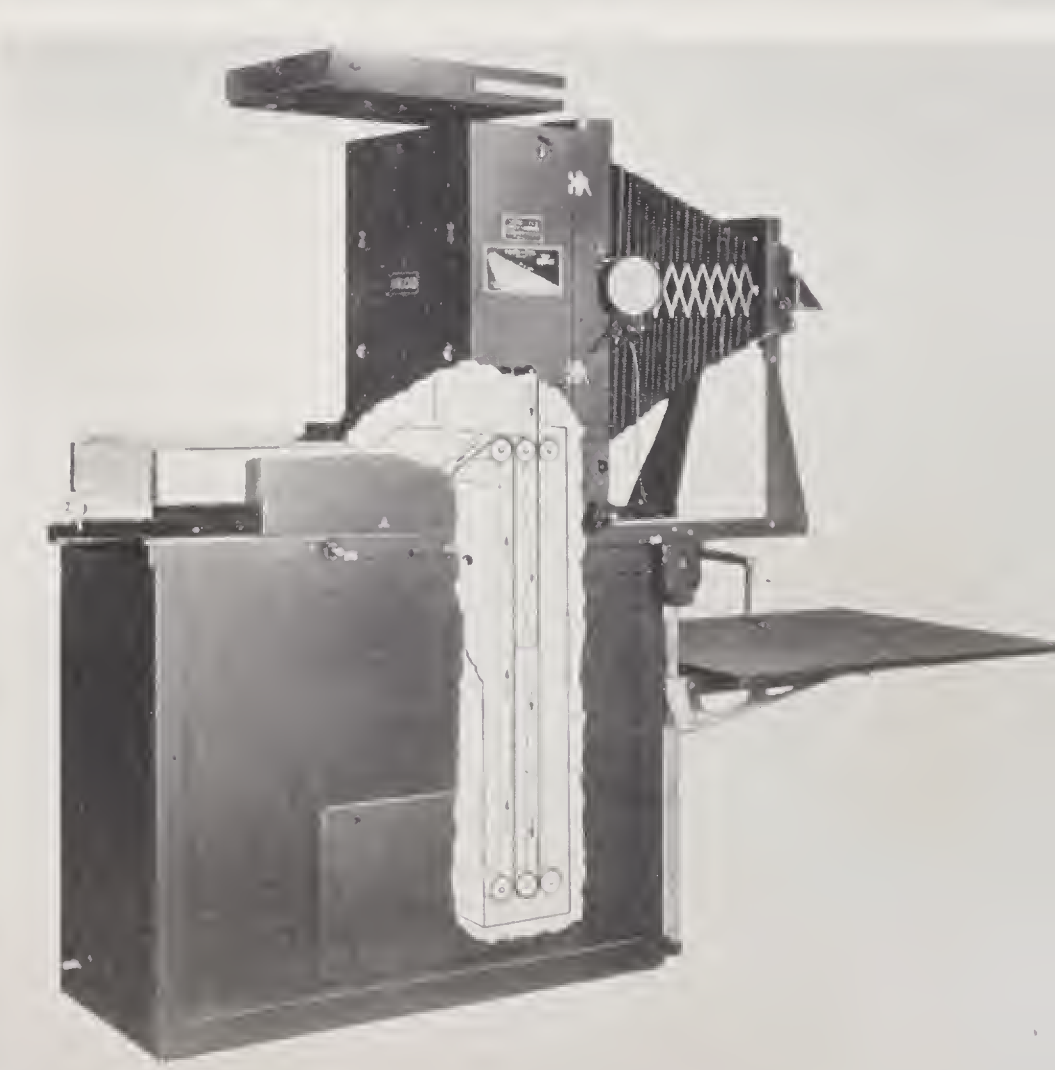
In the vertical range is the well-known Arclight Vertical, which enables rapid and accurate filing and extraction, with maximum protection to the drawing master. The 'Economic' incorporates the same basic system, but is of a lower price. This range also includes filing cabinets of the more conventional type, together with the Railex system.

All these systems have their adherents and the only way of providing a suitable one to meet individual needs is to make a survey of all methods, from literature available from the makers. A careful examination of the information provided should make it possible to select a suitable filing system, able to meet all requirements.

On the following pages are given some typical examples of reproduction apparatus and accessories.



Pedestal Photostat machine
(*Photostat Ltd.*)



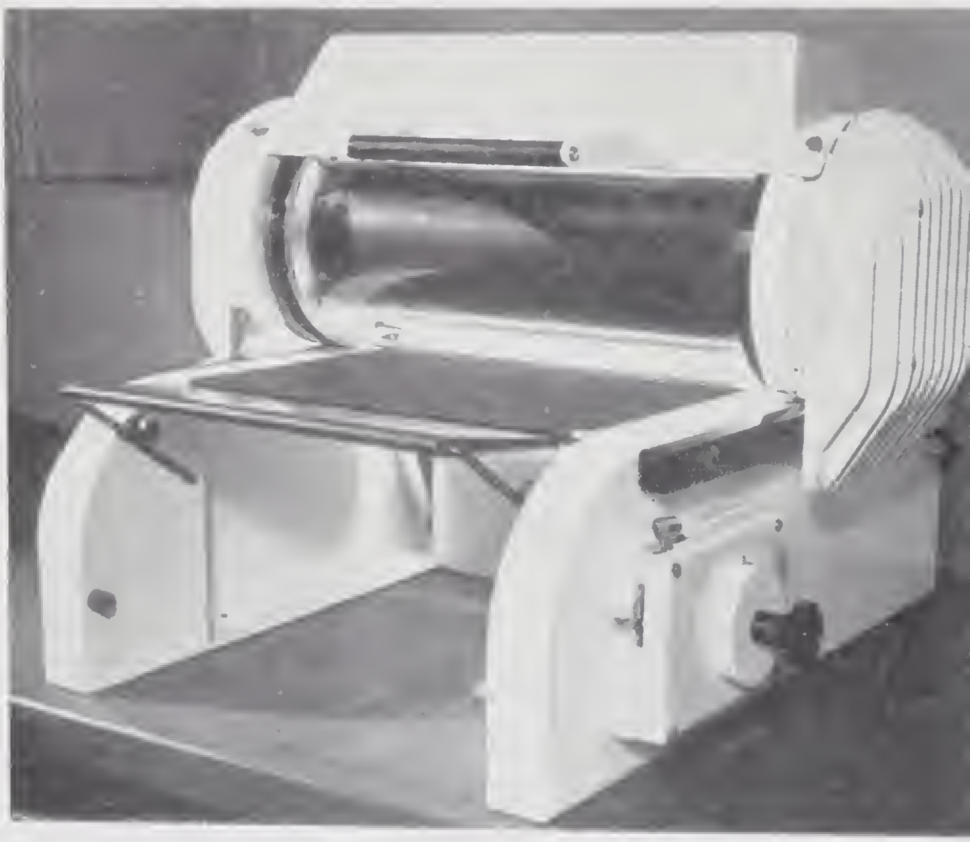
Haloid (U.S.A.) Foto Flo with developing unit

Dyflex combined direct positive and diazo printer (*Remington Rand*)

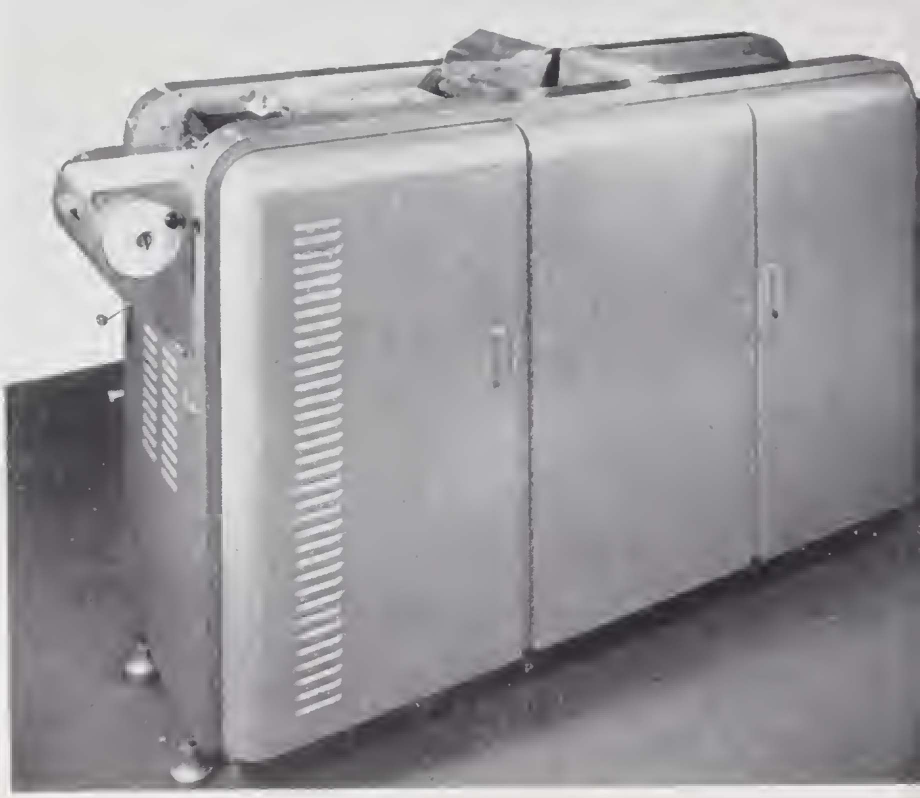
Contoura direct positive printer (*Contoura*)

Duostat direct positive printer (*Kodak*)

Azoflex 529
transfer apparatus
(*Ilford*)



Azoflex model K 10
(*Ilford*)



Azoflex E 50 combined printing and developing machine
(*Ilford*)

'Systematic' automatic diazo machine
(*Copycat*)

C 25
small diazo machine
(*Copycat*)

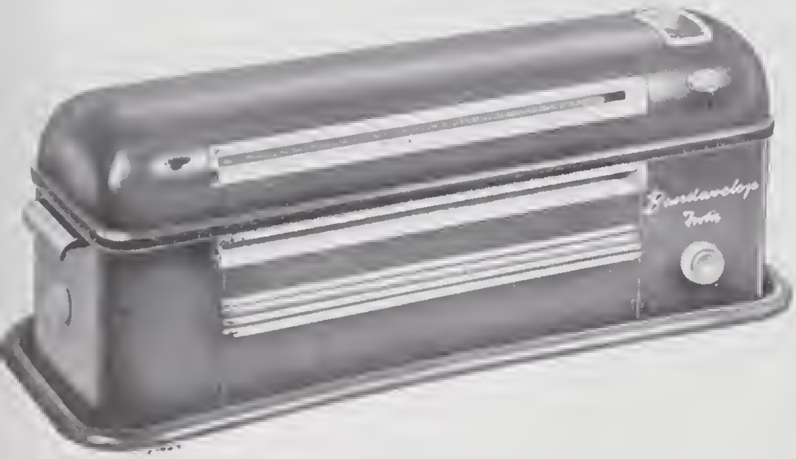
Azoflex
rotary diazo printer
(*Ilford Ltd.*)

Ozalid Lite Writer
ammonia diazo
machine
(*Ozalid*)

Auto Dy-Printer
diazo machine
(*Remington Rand*)

Monex diazo
printing machine
(*Lawes Rabjohn*)

Duplomat
diffusion transfer
single sheet copier
(*Copycat*)

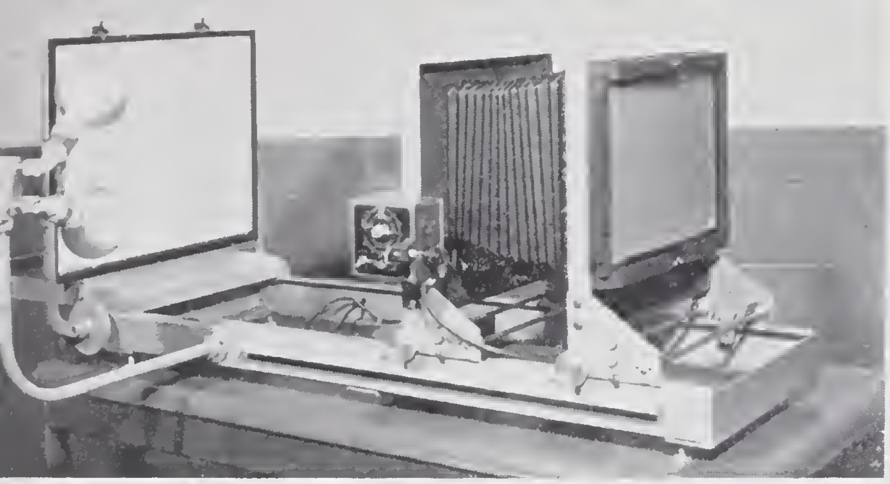


Bandavelop
diffusion transfer
single sheet copier
(*Block & Anderson*)

Mason-copy
diffusion transfer
book copier
(*Mason*)

Verifax photo copying machine
(*Kodak*)

Thermofax photo copying machine
(*Minnesota Mining Co.*)

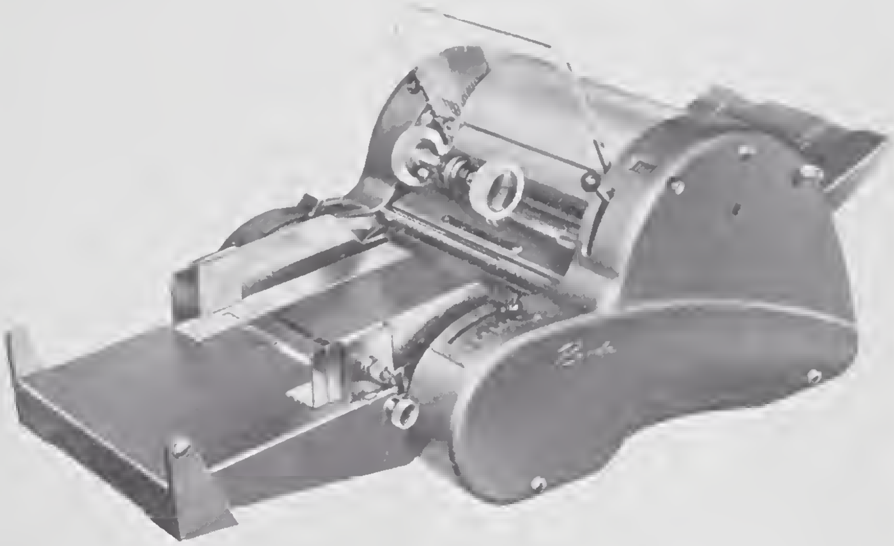


Xerography
copying camera

Xerography
complete unit for
photo copying or
plate making
(*Rank Xerox*)

Xerography
withdrawing the
paper plate

Xerography Copy Flo automatic printing machine (*Rank Xerox*)



Spirit duplicator

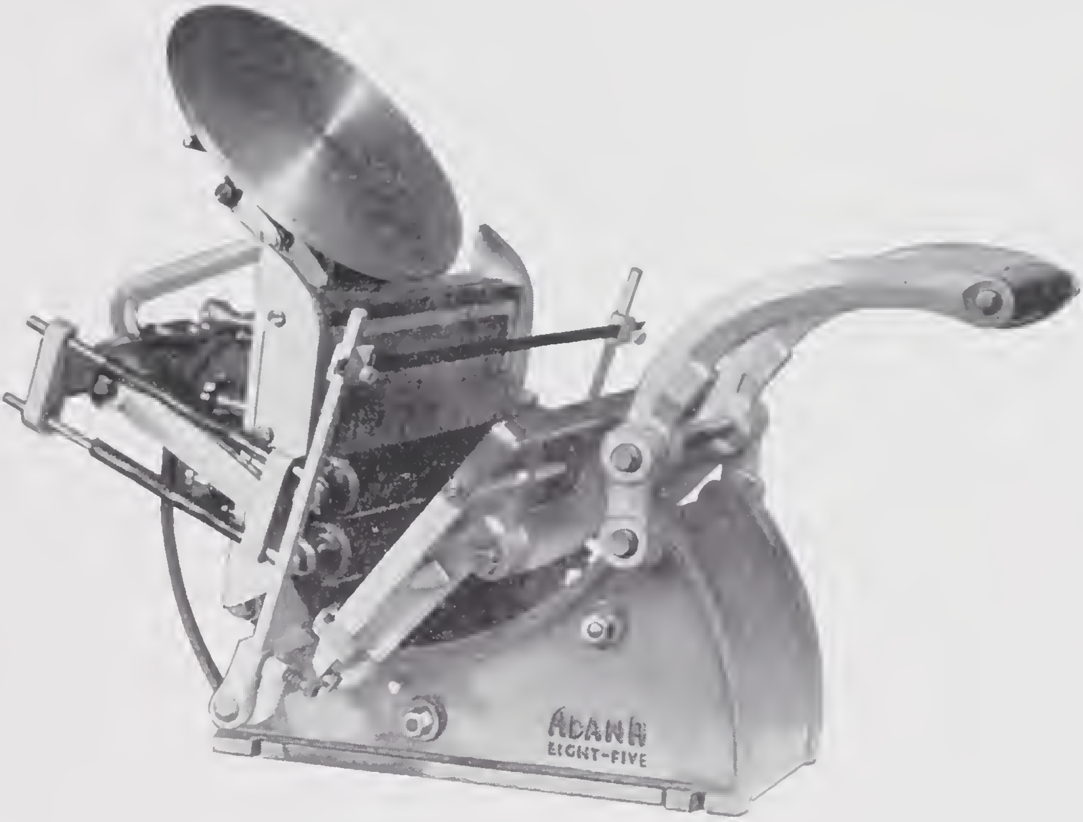
Stencil duplicator

Small offset duplicator

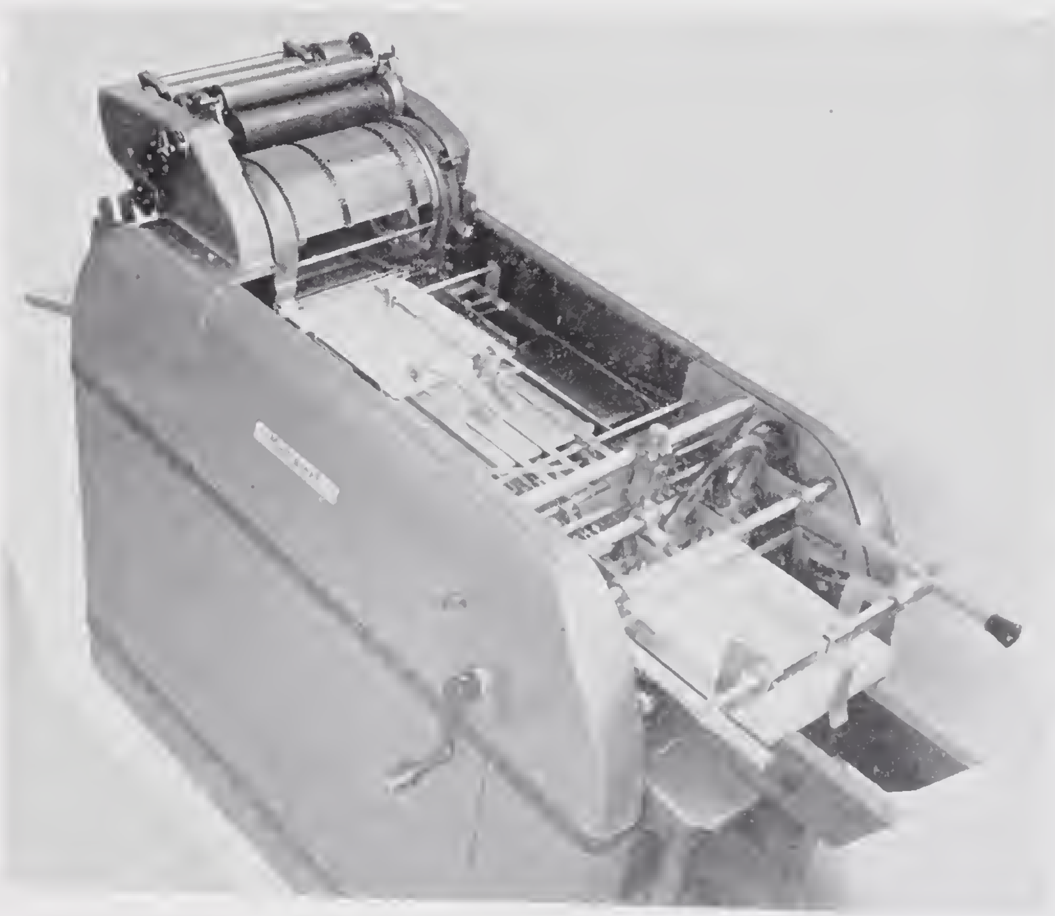
Photoscope photo-stencil camera (*Gestetner*)

Electronic stencil cutter (*Roneo*)

Electronic stencil cutter
(*Remington Rand*



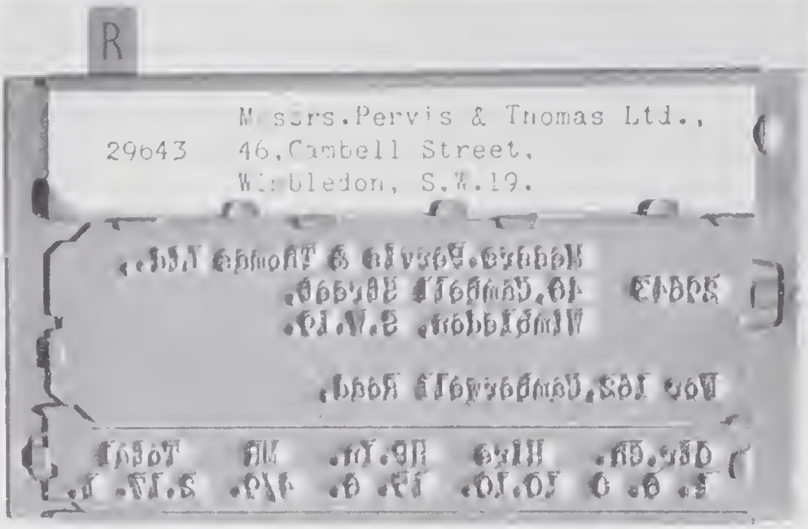
Small relief printing machine (*Adana*)



Rotary relief printing machine (*Addressograph Multigraph*)

Addressing
apparatus
(*Addressograph*)

Addressing
apparatus
(*Bradma*)



Metal addressing plate (3 piece) (*Addressograph*)

Large diazo printing machine (*Ozalid*)

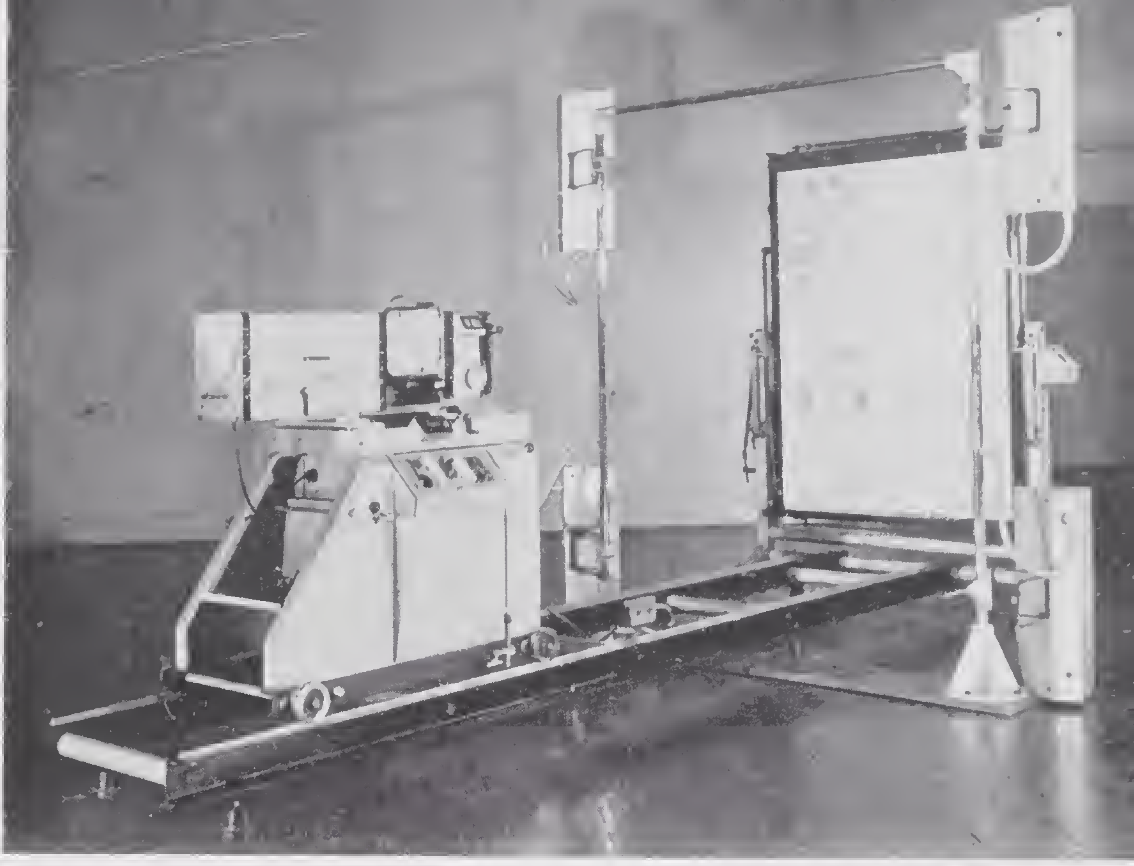
Silk Screen apparatus (*Gordon & Gotch*)

The Dalcopier

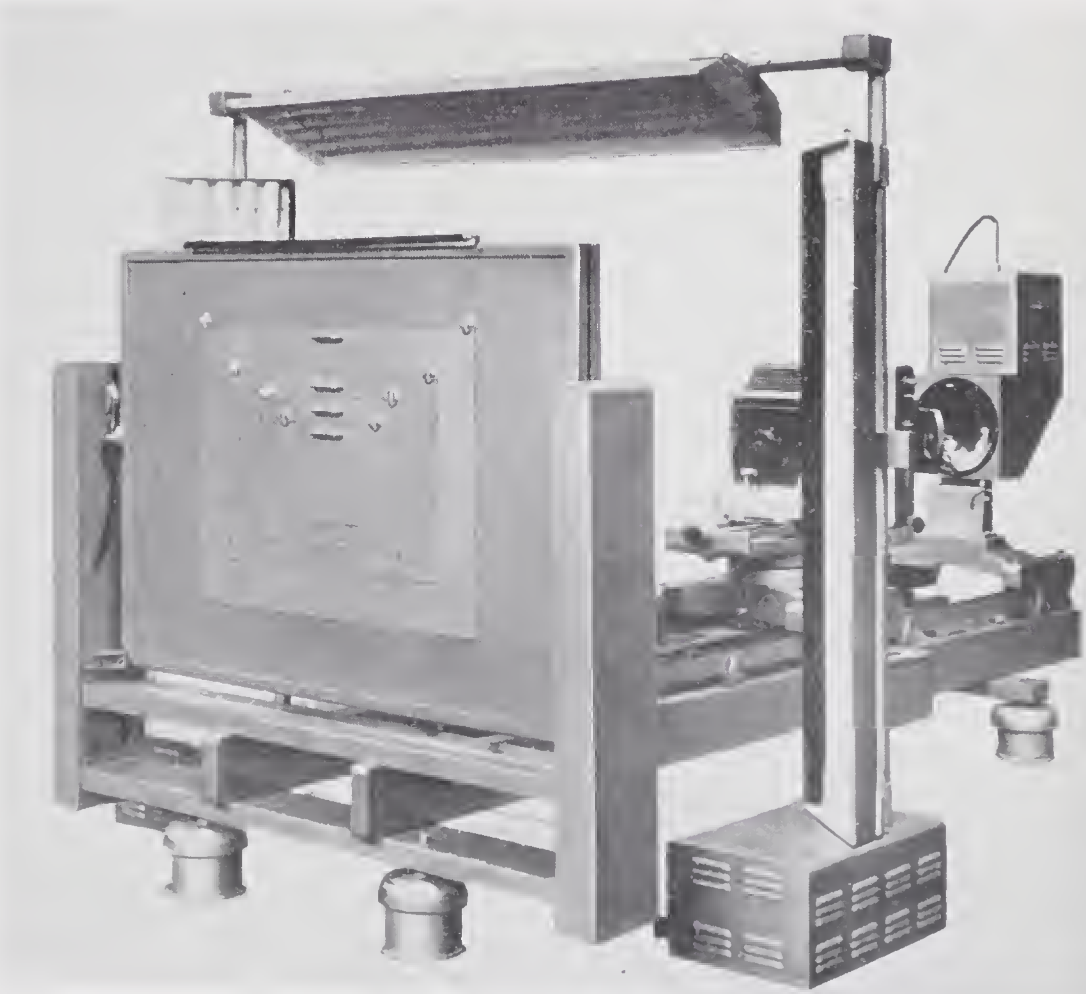
16 mm. microfilm camera automatic type (*Burroughs*)

16 mm. camera and reader combined (*Recordak*)

Microfilm camera 35 mm. stand type (*Recordak*)



State file recorder (*Recordak*)



Barcro camera (*Mason*)

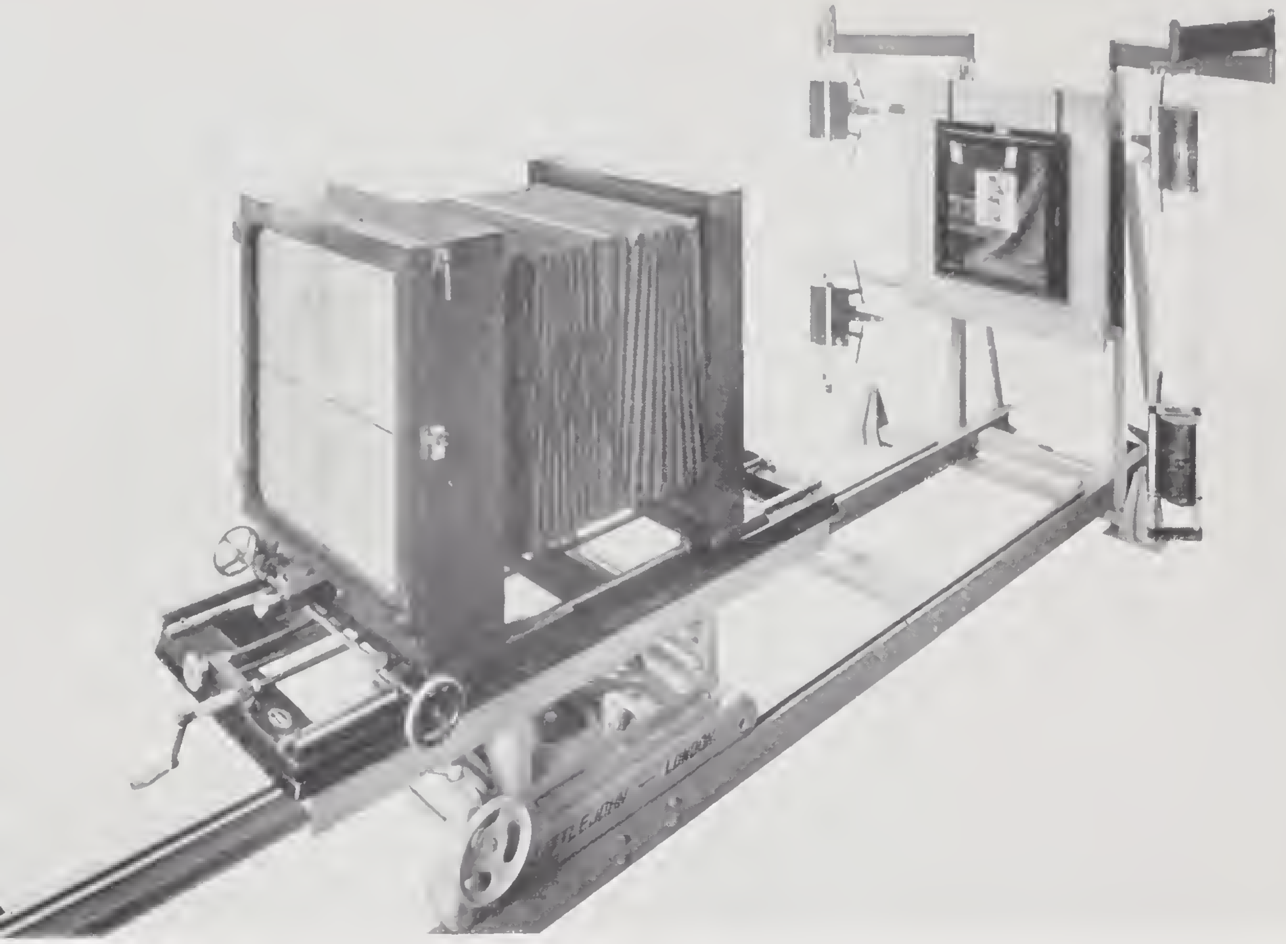
I.B.M. electric typewriter
(*I.B.M.*)

Justowriter recorder
A A model
(*Bulmer*)

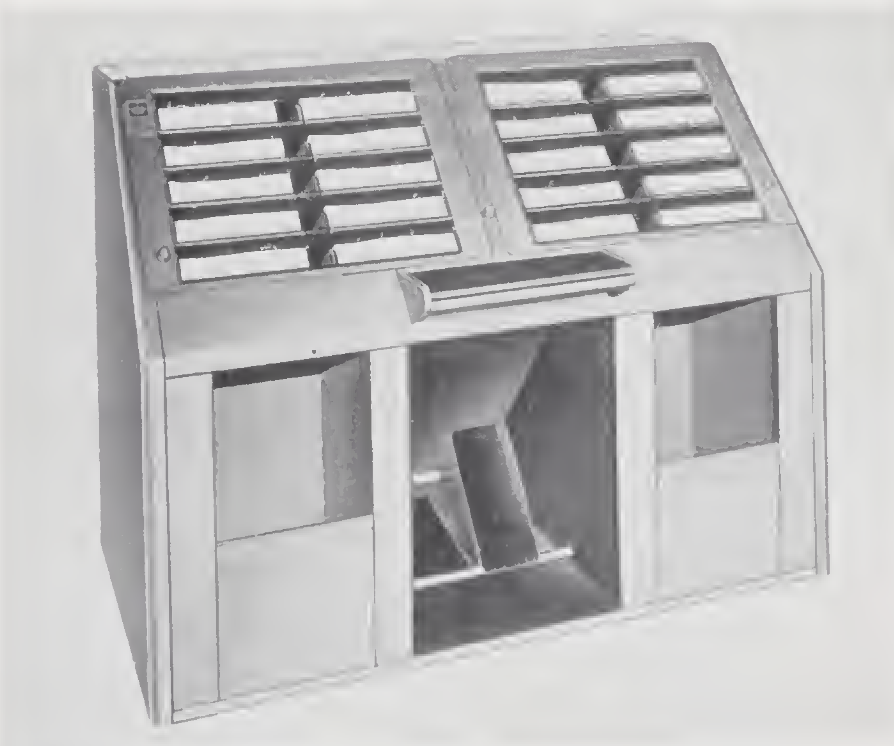
Coxhead typewriter composing machine
(*Varityper Distributors Ltd.*)

'Hubex' process camera office type (*Huber*)

Combined process camera and plate making apparatus (*Pictorial Machinery*)



Large process camera (*Littlejohn*)

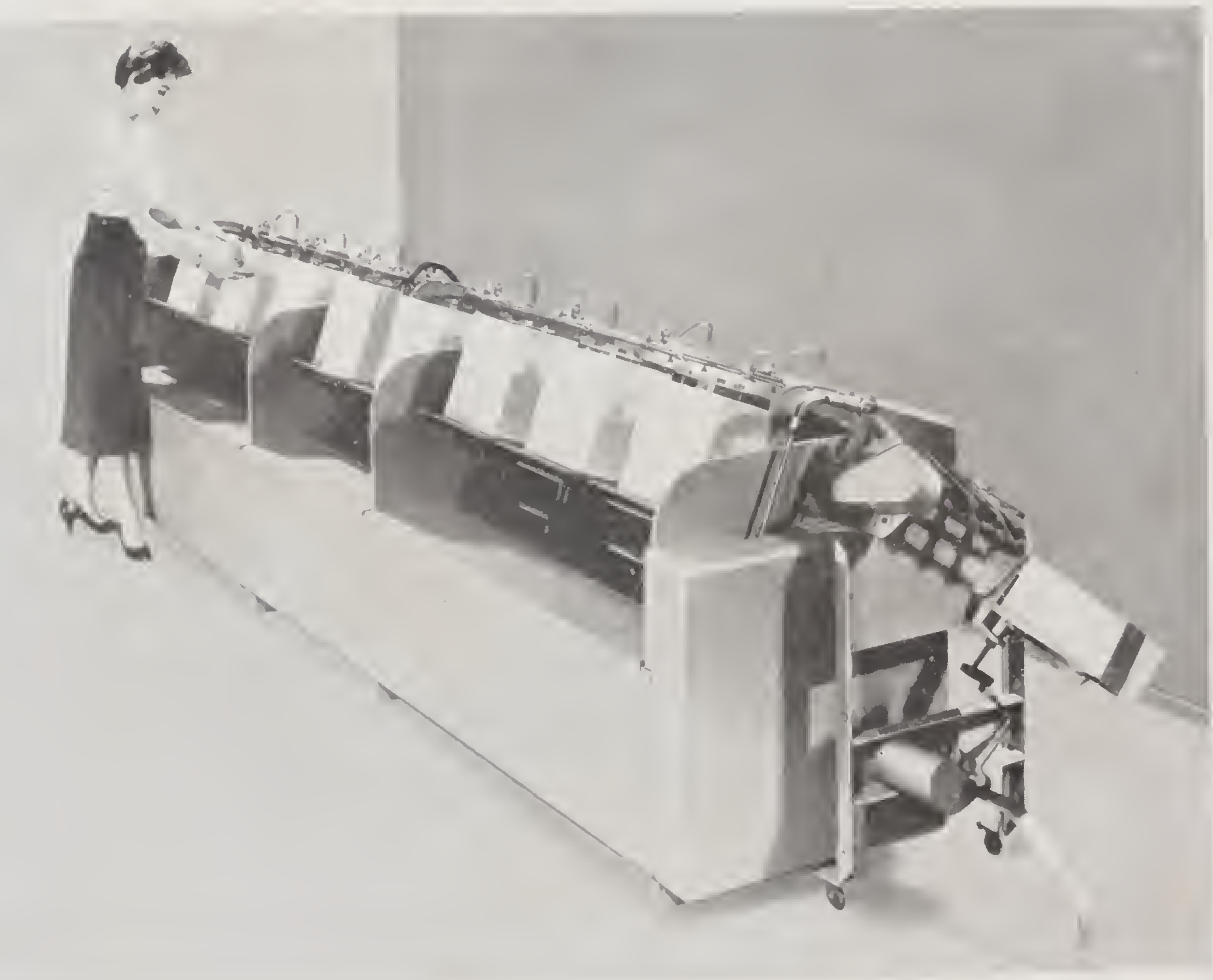


Thomas collator (U.S.A.)
(*Thomas, U.S.A.*)

Metromatic collator
(*Metro*)

Collomatic electric collator
(*Collomatic U.S.A.*)

Accra feed collator
(*Reproduction Products, U.S.A.*)



Macey collator (*Smythe-Horne*)

APPENDIX

DALCOPIER AND POLYPRINT

TWO PROCESSES belonging to the reflex process have now been introduced. Known as Dalcopier and Polyprint they create a negative copy from which further positive copies are made. By employing the quick develop and stabilization method of processing they are able to produce a copy in under one minute. It has been said that the prints produced by these methods are permanent but this claim should be treated with reservation.

Both methods are able to produce good quality copies from practically all colours and all inks and tests have indicated that they are able to give reasonably good copies from half tone reproductions. The same type of paper is used to make both the negative and positive copies, the retail cost being under 3d. per sheet quarto size.

The Dalcopier machines are available for both book or single sheet originals. The latter machine is of elegant design having a row of keys for controlling the exposure during the various operations necessary. The Polyprint is able to copy from both book or single sheets, the exposing and developing units being separated. With both types of machines the processing is continuous, being electrically controlled.

EKTALITH

The Ektalith method of making an offset master, although widely used in the U.S.A. is not generally available in this country. The paper is similar to Verifax but is much more actinic allowing it to be exposed in a camera. The exposed sheet is then developed in a single solution and transferred immediately by contact to a paper offset master. The whole operation takes about two minutes.

Almost any type of original can be used and half-tones up to 133 screen can be reproduced. Solid images are reproduced with acceptable fidelity while backgrounds remain clean. Continuous tone originals can also be copied by exposing Ektalith transfer paper through a contact screen.

Corrections to the master can be made with an eradicator or moistened eraser, and additional information can be added to the plate by writing, drawing or typing before the master is run.

The plates are said to give runs of more than 2,000 copies.

Special apparatus for use with this method has been introduced but, with the exception of the Verifax developing tray it is not essential. As with Verifax a limited number of paper copies can be made from the Ektalith sheet by the usual method of transferring directly to uncoated paper.

CLASSIFIED INDEX TO SUPPLIERS

ADDRESSING EQUIPMENT

Addressall Machine Co., 11-13 Southampton Row, London, W.C.1.
Addressing Machines, Haywood Ltd., 62 Britton Street, Clerkenwell Road, London, E.C.1.
Addressograph-Multigraph Ltd., Hemel Hempstead, Herts.
Adrema Ltd. (Bradma), 2-10 Telford Way, East Acton, London, W.3.
Block & Anderson Ltd., 58 Kensington Church Street, London, W.8.
Business Efficiency Machines Ltd., 16 Douglas Street, London, S.W.1.
Roneo Ltd., 17 Southampton Row, London, W.C.1.

BINDING

Neutronner, Germany.
Soldans Ltd., Burley House, 5-11 Theobalds Road, London, W.C.1.

BLUE PRINT — *see Plan Copying*

CAMERAS

Process Cameras and Ancillary Photo-Litho Equipment

C. H. Budd Ltd., 238 St. John Street, London, E.C.1.
Gestetner Ltd., 210 Euston Road, London, N.W.1.
J. J. Huber Ltd., Hubex Works, Villiers Road, London, N.W.3.
Hunter Penrose Ltd., 109 Farringdon Road, London, E.C.1.
S. R. Littlejohn & Co. Ltd., 22 Brewery Road, London, N.7.
E. N. Mason & Sons Ltd., Arclight Works, Colchester, Essex.
D. O. Nicholl Ltd., 50 Britton Street, London, E.C.1.
Pictorial Machinery Ltd., Kelvin Way, Crawley, Sussex.

Reduction Cameras

De Vere (Kensington) Ltd. (Recorder), Thalia Works, Thayers Farm Road, Beckenham, Kent.
E. N. Mason & Sons, Colchester, Essex (Barcro).
Peerless Neoflow, Peerless Photo Products, Shoreham, Long Island, New York, U.S.A.
Photostat Ltd. (Statfile), Beech Street, London, E.C.4.
Recordak (Listomatic), Beech Street, London, E.C.4.
Integrated Micrographic System.

Studio and Field Cameras and Dark-room Equipment

Agilux Ltd., Purley Way, Croydon, Surrey.
Neville Brown & Co. Ltd., 77 Newman Street, London, W.1.
Kenneth Castiglione, Quadrant Works, Manor Park Crescent, Edgware, Middx.
Colwood Camera Co. (1953) Ltd., 11 High Street, Colliers Wood, London, S.W.19.
De Vere (Kensington) Ltd., Thalia Works, Thayers Farm Road, Beckenham, Kent.
Jonathan Fallowfield Ltd., 74 Newman Street, London, W.1.
G.B. Equipment Ltd., 37-41 Mortimer Street, London, W.1.

Gnome Photographic Products Ltd., 354 Caerphilly Road, Cardiff, Wales.
Ilford Ltd., Ilford, Essex.
Johnson of Hendon Ltd., Hendon Way, London, N.W.4.
Kayfro Instruments Ltd., 40 Carter Knowle Road, Sheffield 7.
Kodak Ltd., Kingsway, London, W.C.2.
Micro Precision Products Ltd., 145 London Road, Kingston-on-Thames, Surrey.
Newton & Co. Ltd., 72 Wigmore Street, London, W.1.
Pullin Optical Co. Ltd., Phoenix Works, Great West Road, Brentford, Middx.
Reid & Sigrist Ltd., Braunstone Works, Braunstone, Leicester.
Savage & Parsons Ltd., Otterspool, Watford, Herts.
W. Watson & Sons Ltd., 313 High Holborn, London, W.C.1.
Wray (Optical Works) Ltd., Ashgrove Road, Bromley, Kent.

COLLATING MACHINES

Block & Anderson Ltd., 58 Kensington Church Street, London, W.8.
Collamatic, Wayne, New Jersey, U.S.A.
Collis & Son, Gray's Inn Road, London, W.C.1.
Currey Mendes Corporation, Curry Lane, Canton, Mass., U.S.A.
Edler Ltd., Torrens Street, City Road, London, E.C.1.
Ellams Ltd., 5 Dean Street, London, W.1.
Evans Ltd., 201 N. 18th Street, Richmond, Virginia, U.S.A.
Gadsby, Camberwell Green, London, S.E.5.
Metro Duplicator Supply Co., 57 Holborn Viaduct, London, E.C.1.
Office Equipment Co., 113 High Holborn, London, W.C.1.
Reproduction Products, 12790 Westwood Avenue, Detroit, Mich., U.S.A.
Addressograph Multigraph, Hemel Hempstead, Herts.
Smyth Horne, 556 Holloway Road, London, N.7.
Thomas Collators, 30 Church Street, New York, U.S.A.
Typographical Engineering Co., 3 Denmark Place, London, N.8.

COMPOSING MACHINES — *see Phototype*

DIAZO MACHINES — *see Plan Copying*

DIAZO PRINTERS, SMALL OFFICE

Anson & Co. Ltd., 58 Southwark Bridge Road, London, S.E.1.
Copycat Associated (Marketing) Ltd., Victoria Street, London, S.W.1.
Darkroom Engineering Co. Ltd., 96 Belsize Lane, London, N.W.3.
Grant Productions Ltd., 4 Rathbone Place, London, W.C.1.
Hall Harding, Dacre Street, S.W.1.
Ilford Ltd., Ilford, Essex.
Lawes Rabjohn Ltd., Victoria Street, London, S.W.1.
E. N. Mason Ltd., Arclight Works, Colchester, Essex.
Ozalid Co. Ltd., 62 London Wall, London, E.C.2.
Remington-Rand Ltd., Oxford Street, London, W.C.1.

DRILLING – SLOTTING – STAPLING

Funditor Ltd., 3 Woodbridge Street, London, E.C.1.
Soag Machinery Co., Juxon Street, London, S.E.11.
Standard Office Supplies, 57 Farringdon Road, London, E.C.1.

DRAWING OFFICE SUPPLIES

D.O.M.M.D.A. (Representing most firms), 157 Victoria Street, London, S.W.1.
Perspector – Isometric Projection Ltd., The Green, Broad Street, Newport Pagnell, Bucks.
Projector (Tracing) – Grant Productions, 4 Rathbone Place, London, W.1.
Traceron – Lloyd & Orr Ltd., Dyeline House, Hook Road, Surbiton, Surrey.

DRYING, GLAZING AND WASHING APPARATUS (PHOTOGRAPHIC)

Copycat Associated (Marketing) Ltd., Victoria Street, London, S.W.1.
Grant Productions Ltd., 4 Rathbone Place, London, W.1.
Ilford Ltd., Ilford, Essex.
Johnsons of Hendon Ltd.
Kodak Ltd., Kingsway, London, W.C.2.
E. N. Mason & Sons Ltd., Arclight Works, Colchester, Essex.
Photostat Ltd., Beech Street, London, E.C.4.
Unit Tool & Engineering Co. Ltd., Sutherland Road West, Blackpool, Lancs.

DUPLICATORS

Damp Paper

Harvey Cook, 60 Weston Street, London, S.E.1.
Roneo Ltd., 17 Southampton Row, London, W.C.1.

Spirit Duplicators

Azograph – A. B. Dick.
Bandagraph – see Block & Anderson.
Block & Anderson, 58-60 Kensington Church Street, London, W.8.
Byron Business Machines Ltd., Ingersoll House, Kingsway, London, W.C.2.
Chemograph.
Ditto (Britain) Ltd., 126-8, New Kings Road, Fulham, London, S.W.6.
Dupl-o-Print Co., 57 Fairfax Road, London, N.W.6.
H. S. Floyd & Co., 120 Pilgrim Street, Newcastle upon Tyne.
Fordigraph Ltd., 35-6 Rathbone Place, London, W.C.1.
Maxlove 'Continuous' Ltd., 19 Tudor Place, London, W.1.
Office Machinery Ltd., 22 Kingly Street, London, W.1.
Orlid, High Holborn, London, W.C.2.
Valmor Ltd., 35-6 Eagle Street, London, W.C.1.

Stencil Duplicators

Andrews Duplicators Ltd., 106 Saffron Hill, London, E.C.1.
Bulmer's (Calculators) Ltd., 7-8 Poultry, London, E.C.2.
Crusader Mfg. Co. Ltd., Berwick Road, London, E.17.
Dupl-o-Print Co., 57 Fairfax Road, London, N.W.6.
Ellams Duplicator Co. Ltd., 5 Dean Street, London, W.1.
Fermaprint Ltd., 17 Fleet Street, London, E.C.4.
H. S. Floyd & Co., 120 Pilgrim Street, Newcastle upon Tyne.
Gestetner Ltd., 210 Euston Road, London, N.W.1.
Gutteridge Samson Ltd., 151 Farringdon Road, London, E.C.1.
Lion Co. Ltd., Gresham Road, Staines, Mddx.
H. A. Moore & Co. Ltd., 4-5 Bridgewater Square, London, E.C.1.
Office Machinery Ltd., 22 Kingly Street, London, W.1.
Remington-Rand, 1-19 New Oxford Street, London, W.C.1.
Roneo Ltd., 17 Southampton Row, London, W.C.1.

Offset Litho (Office Machines)

Addressograph-Multigraph Ltd., Hemel Hempstead, Herts.
Algraphy Ltd., Willowbrook Grove, London, S.E.15.
Gestetner Ltd., 210 Euston Road, London, N.W.1.
Linotype & Machinery Ltd., 21 John Street, London, W.C.1.
Murray Bros., 9-10 New Street Square, London, E.C.4.
Ozalid, Langston Road, Loughton, Essex.
Rotagraph Equipment Ltd., North Lane, Aldershot, Hants.
Rotaprint Ltd., Honeypot Lane, London, N.W.9.

Litho Direct

Lithoset – Orlid, High Holborn, London, W.C.2.

Typeset Machines

Adana (Printing Machines) Ltd., 17-18 Church Street, Twickenham, Mddx.
Addressograph-Multigraph, 29 Kingsway, London, W.C.2.
Dapag Ltd., 23 Holborn Viaduct, London, E.C.1.
Roneo Ltd., 17 Southampton Row, London, W.C.1.
Tickerpress, Dapag Ltd., 23 Holborn Viaduct, E.C.1.

FACSIMILE APPARATUS

Air Associates Inc., 511 Joyce Street, Orange, N.J., U.S.A.
A. Cardwell, Plainville, Connecticut, U.S.A.
Creed Co. Ltd., Telegraph House, Croydon, Surrey.
Electronic Messenger, Air Associates Inc., 511 Joyce Street, Orange, N.J., U.S.A.
Fairchild Inc., J. F. Crossfield Ltd., 2 Elthorne Road, London, N.19.
Ferroprint – 7070 Santa Monica Boulevard, Los Angeles 38, Calif., U.S.A.
Intrafax – Western Union Telegraph Co., 60 Hudson Street, New York 13, N.Y., U.S.A.
Lithofax – Western Union Telegraph Co., 60 Hudson Street, New York 13, N.Y., U.S.A.
Muirhead Co., Beckenham, Kent.
Stenafax, 540 West 58th Street, New York 19, N.Y., U.S.A.
Teledeltos (a dry recording paper) – Western Union Telegraph Co., 60 Hudson Street, New York 13, N.Y., U.S.A.
Electronic Messenger – Air Associates Inc., 511 Joyce Street, Orange, N.J., U.S.A.
Telewriter – Bridge House, 181 Queen Victoria Street, London, E.C.4.
Western Union Telegraph Co., 60 Hudson Street, New York 13, N.Y., U.S.A.

FILES—*see Storage*

FINISHING EQUIPMENT

Adhesive Dry Mounting Co. Ltd., 26 Stamford Street, London, S.E.1.
Bancroft Folding Machines Ltd., Kingham Way, Reginald Street, Luton, Beds.
Blick Office Equipment Ltd., 142 Camberwell New Road, London, S.E.5.
Block & Anderson Ltd., 58 Kensington Church Street, London, W.8.
E. A. Braddick Ltd., 23 Field House, Bream's Buildings, London, E.C.4.
Camco (Machinery) Ltd., New Icknield Way, Letchworth, Herts.
Cropper-Charlton Ltd., Franklin Works, Wright Street, Nottingham.
Crowgroove Ltd., Leyland Works, Neal Street, Bradford 5, Yorks.
Cundall Folding Machine Co. Ltd., Hitchin Road, Luton, Beds.
Furnival & Co. Ltd., Reddish Iron Works, Reddish, Stockport, Cheshire.
Goodhale Distributors Ltd., 174A Perry Vale, Brockley Rise, London, S.E.23.
Hampson Betteridge & Co. Ltd., Belmont Works, 63-7 Belmont Street, London, N.W.1.
Harrild & Sons Ltd., Fleet Works, Norwich Street, London, E.C.4.
Peter Hooker Ltd., 8 Chingford Mount Road, London, E.4.
Hunter-Penrose Ltd., 109 Farringdon Road, London, E.C.1.
T. Kendall & Sons Ltd., French Place, Shoreditch, London, E.1.
Lotz, Abbott & Co. Ltd., Avenue Chambers, 4 Vernon Place, London, W.C.1.
Soag Machinery Co., 7 Juxon Street, London, S.E.11.
Stephenson, Blake & Co. Ltd., 33 Aldersgate Street, London, E.C.1.
Thompson & Langley Ltd., 139-41 Farringdon Road, London, E.C.1.
Unifold Mailing Machines Ltd., 20 Paxton Place, Gipsy Road, London, S.E.27.

FOLDING MACHINES

Bancroft Folding Machines Ltd., Kingham Way, Reginald Street, Luton, Beds.

Block & Anderson, 58-60 Kensington Church Street, London, W.8.
Cundall Folding Machine Co. Ltd., Hitchin Road, Luton, Beds.
J. Miller & Sons, Danes Inn House, Strand, London, W.C.2.
Office Equipment Co., 113 High Holborn, London, W.C.1.
Thompson & Langley Ltd., 54 Farringdon Road, London, E.C.1.
Unifold Mailing Machines, 20 Paxton Place, Gipsy Road, London, S.E.27.
Universal Postal Frankers Ltd., 99-101 Regent Street, London, W.1.

GATHERING APPARATUS – *see Collating*

GUMMING MACHINES

A. T. Gadsby, Camberwell Green, London, S.E.5.

JOGGERS

The Metro Duplicator Supply Co. Ltd., 57 Holborn Viaduct, London, E.C.1.
Office Equipment Co., 113 High Holborn, London, W.C.1.
Markmaster Ltd., 18-20 York Buildings, London, W.C.2.
Masson Seeley & Co. Ltd., 10 Howick Place, London, S.W.1.

MICROFILM CAMERAS

Burroughs Adding Machine Ltd., 356-66 Oxford Street, London, W.1.
Goebels (Flat Sheet Camera) N.D.R., Valerusstraat 28/34, The Hague, Holland.
Kodak Ltd. (Recordak Division), 1-4 Beech Street, London, E.C.1.

MICROFILM READERS

Burroughs Adding Machine Ltd., 356-66 Oxford Street, London, W.1.
Elite Optics Ltd., 31 Frogmoor, High Wycombe, Bucks.
Ilford Ltd., Ilford, Essex.
Kodak Ltd. (Recordak Division), 1-4 Beech Street, London, E.C.1.
Visual Communications Ltd., 17 Denbigh Street, London, S.W.1.

MICROFILM PROCESSING EQUIPMENT

Cinetechnic Ltd., 169 Oldfield Lane, Greenford, Mddx.
Ilford Ltd., Ilford, Essex.
Newman & Guardia Ltd., Harlow Trading Estate, Harlow, Essex.
Photo-Science Ltd., 10 North End Parade, London, W.14.
W. Vinten Ltd., 715 North Circular Road, Cricklewood, London, N.W.2.
Williamson Manufacturing Co. Ltd., Litchfield Gardens, London, N.W.10.

MICROFILM RAPID SELECTORS

Filmorex – 60-74 Rue des Saints Peras, Paris, France.
Minicard – Eastman Kodak Ltd., U.S.A., Recordak Ltd., 1-4 Beech Street, London, E.C.1.
Telemeter – 2000 Stoner Avenue, Los Angeles 25, Calif., U.S.A.

MICROFILM (UNCLASSIFIED)

Integrated Micrographic System.
Kard-a-Film – Remington-Rand, New Oxford Street, London, W.1.
Microstrip, U.S.A.
Visigraph, U.S.A.

NUMBERING

English Numbering Machines Ltd., Queensway, Enfield, Mddx.

OFFSET LITHOGRAPHY – *see Duplicating Processes*

PAPER – DUPLICATING

Duplicating papers are available from most machine suppliers. The following firms will also supply this paper, cut to size or in large sheets.
Grosvenor Chater & Co. Ltd., 68 Cannon Street, London, E.C.4.

Lepard & Smiths Ltd., 42 Earlham Street, London, W.C.2.

Spicers Ltd., 19 New Bridge Street, London, E.C.4.

Strong Hanbury & Co. Ltd., 3 Upper Thames Street, London, E.C.4.

R. T. Tanner & Co. Ltd., Wheatsheaf House, 4 Carmelite Street, London, E.C.4.

Thames House Paper Co. Ltd., Brunel Road, Acton, London, W.3.

PAPER MATERIALS

Autoscript – A. J. Catlin, Jasper Road, Upper Norwood, London, S.E.19.

Film, Reflex and Graphic Art Materials:

Agfa Ltd., Deer Park, Wimbledon, London, S.W.19.

Criterion: see E. N. Mason.

Gevaert Ltd., 184 Acton Lane, London, N.W.10.

Ilford Ltd., Ilford, London.

Kentmere Ltd., Stavely, Westmorland.

Kosmos Ltd., Letchworth, Herts.

E. N. Mason Ltd., Arclight Works, Colchester, Essex.

Photostat Ltd., 1-4 Beech Street, London, E.C.1.

N.C.R. Paper – National Cash Register, 206 Marylebone Road, London, N.W.1.

Paper for Photostat Machines:

Ilford Ltd., Ilford, London.

Photostat Ltd., London, England – Rochester, U.S.A.

Photographic Paper (Silver), Direct Positive Paper, etc.:

Ilford Ltd., Ilford, London.

Kodak Ltd., Kingsway, London, W.C.2.

E. N. Mason Ltd., Colchester, Essex.

Photostat Ltd., 1-4 Beech Street, London, E.C.1.

Photographic Paper – Kodak Ltd., Kingsway, London, W.C.2.

Translucent Paper – Wiggins Teape, Mansell Street, London, E.1.

PHOTOCOPYING PROCESSES

Photostat

Photostat Ltd., 1-4 Beech Street, London, E.C.1.

Direct Positive Apparatus

Burostat – Badenia Ltd., 39-41 New Oxford Street, London, W.C.1.

Contoura – see Reflex Copiers.

Copycat Ltd., Victoria Street, London, S.W.1.

Duostat – Photostat Ltd., Beech Street, London, E.C.1.

Dyflex – Remington-Rand, Oxford Street, London.

Ozalid Co. Ltd., Langston Road, Loughton, Essex.

Remflex – Remington-Rand, Oxford Street, London.

Replictor – Rank Precision Industries, 37 Mortimer Street, W.1.

Reflex Copiers

Contour Photocopying Ltd., 56-60 Islington Park Street, London, N.1.

Copycat Associated (Marketing) Ltd., Victoria Street, London, S.W.1.

Hunter-Penrose Ltd., 109 Farringdon Road, London, E.C.1.

Ilford Ltd., Ilford, Essex

Kodak Ltd., Kingsway, London, W.C.2.

S. R. Littlejohn & Co. Ltd., 22 Brewery Road, London, N.7.

E. N. Mason & Sons Ltd., Arclight Works, Colchester, Essex.

Ozalid Co. Ltd., 62 London Wall, London, E.C.2.

Photostat Ltd., 1-4 Beech Street, London, E.C.1.

Pictorial Machinery Ltd., Kelvin Way, Crawley, Sussex.

A. West & Partners, 4 Abbey Orchard Street, London, W.1.

Diazo Apparatus (Office Type)

Anson & Co. Ltd., 58 Southwark Bridge Road, London, S.E.1.

Azoflex–Ilford Ltd., Ilford, Essex. Van der Grinten, Venlo, Holland.

Copyline, Victoria Street, London, S.W.1.
Darkroom Engineering Co., 96 Belsize Lane, London, N.W.3.
Lawes Rabjohn, Victoria Street, London, S.W.1.
Ozalid Co. Ltd., Langston Road, Loughton, Essex.
Remington-Rand, New Oxford Street, London, W.C.2.

Diffusion Transfer Apparatus

Anson & Co. Ltd., 58 Southwark Bridge Road, London, S.E.1.
Autex Ltd., 166 Piccadilly, London, W.1.
Block & Anderson Ltd., 58 Kensington Church Street, London, W.8.
Copycat Associated (Marketing) Ltd., Victoria Street, London, S.W.1.
A. B. Dick & Co., 140 Theobalds Road, W.C.1.
Hall Harding, Dacre Street, S.W.1.
E. N. Mason & Sons, Arclight Works, Colchester, Essex.
Ozalid Co. Ltd., Langston Road, Loughton, Essex.
Remington-Rand Ltd., 1-19 New Oxford Street, London, W.C.1.

Verifax

Kodak, Photostat – London, England. U.S.A.

Heat Processes

Kalfax – Thomas Moran & Sons, 714 Girod Street, New Orleans, Louisiana, U.S.A.; E. N. Mason & Sons, Colchester, Essex, England.
Thermofax – Minnesota Mining Co., 3 M House, Wigmore Street, W.1. St. Paul, Minnesota, U.S.A.

Electro-Photographic

Electrofax – Radio Corp. of America, Camden, New Jersey, U.S.A.
Photronic Reproducer – The Standard Register Co., Dayton 1, Ohio, U.S.A.
Xerography – Haloid, Rochester, N.Y. U.S.A.; Rank Xerox, Mortimer Street, London.

PLAN COPYING

General Enquiries, D.O.M.M.D.A., 37 Victoria Street, London, S.W.1.

Blue Print, Dyeline and True-to-Scale Equipment and Materials

C. H. Budd Ltd., 238 St. John Street, London, E.C.1.
Grant Productions Ltd., 4 Rathbone Place, London, W.1.
J. Halden & Co., 28-30 Great Peter Street, London, S.W.1.
Hall, Harding Ltd., Stourton House, Dacre Street, London, S.W.1.
Lawes Rabjohn Ltd., Abbey House, Victoria Street, London, S.W.1.
E. N. Mason & Sons Ltd., Arclight Works, Colchester, Essex.
Arthur Morris, 19 Duke's Lodge, Holland Park, London, N.W.11.
Nig Mfg. Co. Ltd., 3-9 Dane Street, London, W.C.1.
Norton & Gregory Ltd., Castle Lane, London, S.W.1.
Ozalid Co. Ltd., 62 London Wall, London, E.C.2.
Precision (Photo-printing) Plant Ltd., Station Estate, Balmoral Road, Watford, Herts.
A. West & Partners, 4 Abbey Orchard Street, London, S.W.1.

PHOTOSCOPE

Gestetner Ltd., 210 Euston Road, London, N.W.1.

PHOTOSTAT

Photostat Ltd., 1-4 Beech Street, London, E.C.1.

PHOTOTYPE COMPOSING MACHINES AND METHODS

Artype
Cox Headliner – Gestetner Ltd., 210 Euston Road, London, N.W.1.
Filmotype.
Fototype.
Sagenta.
Typro.

Railex – F. Wilson & Co., 11 Lockington Street, London, E.C.2.
Rolafile.
Roneo Ltd., 17 Southampton Row, London, W.C.1.
Stencil Filing Co., Bowers Parade, Harpenden, Herts.
Suspendex – Norwood Steel Equipment, 149 Borough High Street, London, S.E.1.

STORES CONTROL

Movigraph.
Vidento.

TINTS – *see Shading Mediums*

TRACERON

Lloyd & Orr Ltd., Hook Road, Surbiton, Surrey.

TRANSLUCENT PRINTERS – *see Diazo*

TYPEWRITERS – SPECIAL AND JUSTIFYING MACHINES

Block & Anderson Ltd., 58-60 Kensington Church Street, London, W.8 (Justowriter).
British Olivetti Ltd., 10 Berkeley Square, London, W.1 (Olivetti).
Bulmers, 47 Worship Street, E.C.2.
IBM United Kingdom Ltd., 17 Berkeley Street, London, W.1 (IBM).
Imperial Typewriter Co. Ltd., East Park Road, Leicester (Double-Bank).
Justitype – Fototype Inc., 1414 Roscoe Street, Chicago, Ill.
Mercedes Sterling Book-keeping and Calculating Machines Ltd., 11 Ludgate Circus, London, E.C.4 (Mercedes).
Optype – Logerbak, 21 Buckingham Palace Road, S.W.1. Ateliers, Bariquand et Marre, 79 Avenue Aristide Briand, Arcueil, Seine, France.
Remington-Rand Ltd., 1-19 New Oxford Street, London, W.C.1 (Remington).
Typewriter Sundries Co. Ltd., 30 New Bridge Street, London, E.C.4 (Adler).
Underwood Business Machines Ltd., 412 New Oxford Street, London, W.C.1 (Underwood).
Vari-typer Distributors (Gt. Britain) Ltd., 210 Euston Road, London, N.W.1 (Vari-typer).
The Visible Writing Machine Co. Ltd., 36 Worship Street, London, E.C.2 (Royal).

UNO

A. West & Partners, 4 Abbey Orchard Street, London, S.W.1.

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GLOSSARY OF REPRODUCTION TERMS

ACID RESIST. A protective coating which is acid proof, is applied to metal plates before etching.

ACHROMATIC LENS. A lens corrected for black-and-white photography.

AIR BRUSH (Aerograph). A small spray gun used by artists when retouching photographs, drawings, etc., to improve their tonal value.

ALBUMEN PROCESS. The most commonly used sensitizer for coating photo offset plates.

ALBUMEN SOLUTION. Egg albumen scales mixed with water and ammonium hydroxide.

ALUMINIUM PLATES. Highly flexible plates used in the offset process.

ANASTIGMAT. A lens corrected for astigmatism.

ANHYDROUS. Water-free. Used normally with reference to chemical salts and solvents.

APERTURE. The diaphragm or opening of a lens – often referred to as the 'stop'.

ARC LAMPS. A powerful light source gained from an incandescent arc of light formed between two electrodes.

ARTYPE. Type faces which are printed on acetate sheets gummed on the back. The required letters are cut out of the sheet and pressed into the required position to create 'copy'. This is photographed and printed by offset.

BENDAY PROCESS. A mechanical method of applying 'tints' or texture patterns to drawings and printers' plates to give various tones or shadings. Similar effects are given by Zip-a-tone, Craftint and others.

BINDING. A method of holding the pages of a book together; spiral, plastic, saddle stitched, etc.

BLANKET. A resilient rubber blanket on to which the image is transferred or offset from the inked lithographic plate.

BLANKET POWDER. An absorbent powder for removing excess tackiness from the surface of the blanket.

BLANKET WASH. A preparation for washing the image from the rubber blanket.

BLEED (Bleeding). An illustration that runs off the edge of the paper, so that there is no white margin in the layout.

BLEED (Diazo). Refers to the dye image which has run or spread.

BLOCK. Wood or metal base on which a printing plate is mounted. Also used to indicate a relief printing plate.

BLOCKING OUT. The use of opaque, indian ink or other means to fill in a negative so that the areas do not print.

BLUEPRINT. Made on ferro-prussiate paper from a translucent original (Plan Copy Process).

BROCHURE. Booklet or folder.

BROWN PRINT. See Sepia Negative.

CAMERA. Apparatus fitted with lens and means for holding plates or films for making photographs.

CAPS. Capital letters.

CAPTION. Heading or title to an illustration.

CARBRO. A photographic colour print process.

CHASE. A metal frame used to hold relief type in position when printing. Also the carrier used on photocomposing machines.

COLLATE. Assembling together in correct sequence.

C.P. 'Chemically Pure.'

COLOUR FILTER. Coloured gelatine, glass or plastic used on the lens to absorb certain colours.

COLOUR SENSITIVITY. Defines the response given to various colours by the sensitive emulsions. Ordinary process emulsions are sensitive only to blue and ultra-violet light. Panchromatic emulsions are sensitive to all the colours of the spectrum.

COLOUR SEPARATION. A term used normally in negative making when filters are used to separate colours for creating separation negatives for colour printing.

COLOUR SEPARATION NEGATIVE. A colour negative which has recorded a primary colour by the use of a colour filter.

COLOUR TRANSPARENCY. A positive colour image on a transparent support.

COLOURS (Primary). The three basic colours from which all others are obtained by mixing.

COMBINATION (Plate–print). Combining both line and half-tone images.

CONTACT. Made in direct contact.

CONTACT SCREEN. Screens designed to be used in contact with the emulsion.

CONTINUOUS PROCESSING. Processing in machines which automatically transport the photographic material through the required solutions, finally drying the product.

CONTRAST. The range between the extreme tones in a print or a negative.

COPY. Frequently refers to material to be reproduced, but can also be the printed result from an original.

COPY-BOARD. A board designed to hold the copy when being photographed.

COPY-HOLDER. A device which may be a simple board or an elaborate vacuum frame designed to hold the copy before the camera.

CROP. To cut down printing plates or illustrations.

DAMPING SOLUTION. The special liquid used with a lithographic plate.

DECKLE. Originally referred to the natural rough uncut edge of hand-made paper.

DEEP-ETCH PROCESS. A lithographic plate-making process in which the printing lines are etched slightly below the plate surface.

DELIQUESCENCE. Tendency to absorb atmospheric moisture.

DENSITOMETER. Photoelectric instrument for measuring the density of the photographic negative or positive.

DENSITIZING (Litho). Making a lithographic plate insensitive to greasy ink.

DENSITY. The relative quantity of exposed and developed silver salt in each unit area of the photographic image.

DEVELOPER. Chemical solution for the development of the latent image.

DEEP ETCH. A method of preparing litho plates. It is claimed to give better quality and longer runs.

DIAPHRAGM CONTROL. A device for indicating the correct aperture for any camera extension and screen ruling when using process cameras.

DIAZO (Dyeline). A dye-coated paper which will produce a copy directly by exposure to a transparent or translucent original. The sensitive dye is

bleached by exposure to light, the unbleached portions can be developed by a liquid developer or ammonia fumes, according to the type of paper used.

DIFFERENTIAL SPACING. Type on which each character is spaced according to its individual width. The opposite of UNIT spacing.

DIFFUSION TRANSFER. A photocopying method which produces a positive by chemical diffusion from the negative, e.g. Agfa rapid, Gevacopy.

DIRECT-IMAGE PLATE. A plate on which an image can be directly applied.

DIRECT POSITIVE. A photographic paper which gives a positive copy by direct exposure and development to a positive original.

DISPLAY TYPE. Comparatively large type used for headings, title pages, headlines and posters.

DOUBLE PRINTING. Two printings on the same sheet.

DOUBLE IMPOSITION. A second image created on a lithographic plate by resensitizing and printing down after the first image has been imposed.

DRAWING. Pencil, ink or other medium on paper, cloth or other material. The drawing prepared by a draughtsman is usually on translucent material and is sometimes (erroneously) referred to as a negative.

DUMMY. Preliminary rough sketch, layout or paste-up to indicate the final appearance of the completed job.

DUPLICATOR. A machine for duplicating copies normally of the hectographic, stencil or offset process.

DUPLIMAT. A proprietary short-run plate for use on offset machines.

EMULSIFY. Inks which permit water to mix with them.

EM. Printing term denoting the square of the body type.

EN. Half of an EM (in width).

ENLARGEMENT. Of a larger size than the negative or the original copy.

ERADICATOR. A solution for making corrections on intermediates.

ERASER (Glass). Made of spun glass, for removing errors on offset plates.

ETCHING (Offset). Applied to the developed litho plate to de-sensitize the ink.

ETCHING, DOT. A method of reducing the size of the dot on half-tone negatives or positives.

EXPOSURE. The length of time a plate or film is exposed. This time varies according to the light value, lens stop used, sensitivity of the plates, the type of original being copied and the relative size of the copy being produced.

F/NUMBER. Refers to the number used on the lens mount which is controlled by the iris diaphragm. It indicates the diameter of the aperture in relation to the focal length of the lens.

FILMS, PHOTOGRAPHIC. A flexible base on which light-sensitive emulsions are coated. Films vary in type, contrast, colour sensitivity and speed, meeting a wide range of uses.

FILTER. Coloured transparent material which is intended to absorb certain colours.

FIXER. A solution which dissolves silver salts remaining in photographic material.

FLAT COPY. A copy having no contrast, not normally suitable for process work.

FLASH EXPOSURE. A supplementary exposure given to white light or material for strengthening the shadow dots.

FLUSH. Even with the edge.

FOCAL LENGTH. The distance between the lens and the image when a lens is focused on infinity. The focal length of a lens determines (wide angle excepted) its covering and the size of the picture it will make. The normal lens used generally has a focal length equal to the diagonal of the largest plate to be used in the camera.

FOCAL PLANE. The plane where a focused lens is in sharp focus.

FOCUSING. Bringing a camera into correct image size and sharpness.

FOG. Photographically refers to unwanted light falling on the sensitive emulsion, thereby giving a tone or background when developed.

FOLDING MACHINE. Apparatus able to fold sheets of paper into one or more folds.

FOLIO. A page number; number of words (72 or 90), or a unit of length in a document.

FORMAT. The size, style, shape and general appearance of any printed material.

FOUNT. Set of type of same face and size.

FOUNT. Used in the offset process as a proprietary article. The purpose is to protect the areas of the plate which do not contain ink.

GRADATION. The gradual passage of tones from one to another.

GRAIN. The direction of fibres in paper.

GRAIN OFFSET. Fine abrasion to allow the plate to retain moisture.

GRAVURE. A commercial method of printing. It does not use relief type or letterpress. The image is etched into a copper plate and therefore printing is from a sunken, or intaglio, image. In printing, the ink is pulled out of the etched part to form a copy on the paper.

GROUND GLASS. Special glass used in the back of a camera in the same plane as the sensitizing emulsion, for focusing the image.

GUM ARABIC. A solution used to preserve offset plates.

GUMMING UP. Applying to an offset plate a solution of gum arabic to protect it from grease and oxidation.

HALATION. The spreading of light generally found around the highlights of the image.

HALF-TONE. A photograph which has been reproduced through a screen to enable its reproduction on a printing machine. The screen breaks the transmitted image into small dots, the variations in size of which give the illusion of tonal values and the term 'half-tone'. All the ink dots are of the same colour, having no tonal variation, but a number of large dots create the impression of a black area whilst the same number of small dots appear as various tones of grey.

HEADING. The title or headline at the beginning of a page, section, column, paragraph, etc.

HIGHLIGHT. The brightest areas in the original and therefore the darkest portions on the negative.

HUMIDITY. The moisture content of the air.

HYGROMETER. An instrument which determines the moisture content of the air.

IMPRESSION CYLINDER. One of the main cylinders on the offset machines.

INDIAN INK. Chinese ink. A drawing ink having great density, used to create drawings designed for reproduction.

INFRA-RED. Light having a longer wave-length than visible light.

INTERMEDIATE, OR PRINTING MASTER. See Master, Intermediate.

JUSTIFY. To space out so that the right-hand margin is even.

LAYOUT. Design or plan to indicate how the final copy will appear. Often an artist's conception.

LEGEND. Title, description or caption.

LENS. Elements of optical glass assembled according to a mathematical formula, giving an image of sharp definition. Process lenses are designed to give a sharply defined image on a flat plane.

LENS COVERING POWER. The ability of a lens to cover a given area with good definition even in the corners.

LENS FOCAL LENGTH. See focal length.

LENS STOPS. See f/numbers.

LETTERPRESS. A commercial method of printing from relief or raised type.

LETTER SPACING. Giving additional space between individual letters.

LINE DRAWING. A drawing without tone values.

LINE ENGRAVING. A letterpress printing plate made from line copy. Usually etched on zinc.

LINOTYPE. A typecasting machine which casts an entire line of type in a single piece.

LITHO CRAYON. A special crayon for drawing on litho plates.

LITHOGRAPHY. A major commercial printing process, making copies from a planographic surface.

LITHOGRAPHIC RIBBON. A special ribbon used for direct typing on lithographic plates.

LOWER CASE. Small letters of the alphabet; minuscule.

MAKE READY. The time taken to prepare a duplicating machine before making the copies.

MARGINS. The border or frame surrounding a printed page.

MASTER. The prepared material from which copies are made.

MASTER, INTERMEDIATE. Prepared from the original or the master, and made suitable for the process to be used.

MAGENTA SCREEN. A special contact screen made for creating half-tones.

MIDDLE TONES. The tones which lie midway between the highlights and the shadows.

MONOTYPE. Keyboard casting machine for type composition.

NEGATIVE. Photographically the opposite to a positive, having the tones reversed; thus the white in the copy becomes black on the negative.

NEGATIVE PAPER. A special paper for negative making.

OFFSET. To transfer. Offset lithography differs from direct photography in that the image is transferred from the plate to a hard blanket and is finally again transferred to the printing paper.

OPAQUE. Light-proof.

OPAQUEING. Painting a negative with an opaque liquid to block out pin-holes and other defects, or render certain parts unprintable.

ORTHOCHROMATIC. Photographic materials which are sensitive to green and yellow as well as blue light.

OXIDATION. An action given when air contacts the unprotected areas of litho plates not adequately gummed.

PAGINATION. Numbering pages of a book or other printed matter.

PANCHROMATIC. Photographic material sensitive to all visible colours and also ultra-violet light.

PAPER PLATE. A paper plate which is prepared by typing, drawing, etc., for use on the offset process. They are also available pre-sensitized.

PASTE-UP. Material which has been pasted in position for making a new copy negative.

PETIT ROMAN TYPE. A standard typewriter type having 16 letters to the inch.

PH. The measure of acidity or alkalinity of a solution.

PHOTOCOPY. A copy made by one of the photocopying processes.

PHOTOFLOODS, LIGHTS. Over-run incandescent bulbs giving a very brilliant light for a short period of a few hours only. They can be fitted into existing lampholders.

PHOTOSTAT. A photocopying process using a lens and a prism, thus giving a negative reversed in tone but reading correctly. It is a registered name given to a proprietary machine and the prints produced by it.

PHOTO TRACING. A drawing reproduced as a positive on photographic film, cloth or thin paper.

PIN HOLES. Tiny, round transparent dots which appear after development. They are normally removed with an opaque medium.

PICA. A standard unit of type measurement. 12 points or almost 1/6th of an inch.

PLATE. The name used photographically when emulsion is coated on to glass plates. In lithography it refers to the master and may be of metal, plastic or paper. The gelatine coating used in the Ordoverax process is also referred to as a plate.

POSITIVE. Material which produces reversed tones from a negative or direct tones from a positive.

POINT. Printing unit, about 1/72nd of an inch.

PRINTING LAMP. Lamps used for exposing sensitive material. In pure photography they are normally tungsten type, in photo-mechanical work, arc or high-power pressure mercury lamps are often used.

PRINT. Normally a black line, white background copy, made from a negative or other intermediate.

PRINT BACK. A direct-reading print made from a reversed intermediate.

PROCESS CAMERA. A large camera usually fitted on rails and with special devices for holding and illuminating the copy. It is used chiefly in connection with the photo-mechanical processes.

PROOF PRESS. A small press used professionally for making proofs.

QUIRE. 25 sheets.

REAM. 500 sheets of paper.

REDUCTION. Making to a smaller size.

REFRACTION. The deviation of a light ray from a straight path.

REGISTER. A position on a printing plate which enables different runs to have no overlap.

RETICULATION. A blemish in the form of an irregular pattern caused by the rapid expansion and shrinkage of gelatine film when subjected to high or different temperatures.

RE-TOUCHING. The application of pencil, dye or paint to a photographic negative or print to improve its quality.

REVERSE. Often used to denote art work which is white on a dark ground.

REVERSAL PROCESS. A method of converting a negative to a positive by bleaching and re-exposing the emulsion before fixing.

REVERSE READING. Having the image left to right. Also called 'mirror reading'.

RIBBON, CARBON. A continuous strip of carbon used in all forms of typewriters.

RUBBER CEMENT (SOLUTION). An adhesive used to make paste-ups, etc.

SADDLE STITCH. A method of binding a booklet, etc., by stitching or stapling through the middle fold.

SAFELIGHT. A filter which, when fitted in a container having an electric light bulb, allows only 'safe light' to be emitted.

SCREEN, CONTACT. Screens used for half-tone reproduction in contact with the sensitive emulsion.

SCREEN DISTANCE. The distance at which a half-tone screen is placed to bring the dot into focus on the sensitive emulsion.

SCREEN, HALF-TONE. A glass screen ruled with a number of lines varying from 55 to 400 per linear inch. Those normally used in minor offset are 110 to 133 lines per inch.

SCREEN RULING. The number of lines per linear inch in a screen gives its ruling.

SENSITIZERS. Light-sensitive solutions which, when applied to a plate or other material, allow their use by photographic means.

SCUM. A thin coating of ink which appears on litho plates, due to a breakdown in the de-sensitizing solution.

SEPIA NEGATIVE. A brown background negative made on iron-silver-sensitized paper, used as an intermediate in making shop prints from drawings: sometimes called 'brown print'. Positive prints made on such paper are usually called 'brown line prints'.

SIDE STITCH. Binding a booklet, etc., by stitching or stapling through the left hand edge from front to back. This method does not allow the book to open as flat as will a saddle-stitched booklet.

SPINE. The back of a book.

SPOTTING. Opaqueing pin-holes and other blemishes on a negative, or white areas on a print.

STABILIZER. A solution used in the place of hypo to fix developed prints – it is not necessary to wash the print after stabilizing unless permanency is required.

STOCK. Printer's term for paper.

STOP BATH. A dilute acid solution which is intended to neutralize the alkaline in the developer, thereby stopping action.

STRIPPING DEVICE. With Azoflex. To remove the half-tone screen from the diazo film after development.

TINTS. Materials which can be applied to drawings to give special shading effects, e.g. half-tones.

TINTING. The application of shading or special effects to art work.

TINTING (Offset). A plate which has scum is said to be tinting (or scumming).

TONE, CONTINUOUS. Refers to a photograph on photographic paper having a scale of tones, usually about 30, ranging from white to black.

TRACING. A drawing which has been traced, normally on a translucent base material.

TRANSPARENTIZING. Use of mediums to make the paper base of an intermediate more translucent and thus increase the printing speed.

TYPE, RELIEF. Principally a letterpress term. Normally made of metal and available in a wide variety of faces and styles. Also is available in different sizes called points, a point being 1/72nd of an inch.

TYPOGRAPHY. The art and technique of arranging printing. The appearance, arrangement and style of reading material.

ULTRA-VIOLET. Light having a shorter wave-length than that of visible light.

UNIT SPACING. Where each character occupies a unit of space (the reverse of proportional spacing).

UPPER CASE. Signifying capital letters.

VACUUM FRAME. A printing box designed to give close contact between the negative and the plate.

VELLUM. A superior translucent material.

VESICULAR. Cellular.

VIGNETTE. Gradually shaded off towards the edges.

WATERHOUSE STOPS. Found chiefly in old lenses where the iris diaphragm is replaced by a metal strip, having the stop or lens aperture cut out of the centre. The strip is inserted in the lens barrel and each stop is a separate strip of metal.

WHIRLER. A device which rotates a lithographic plate whilst the sensitizing solution is being applied.

WHITE PRINTS. Copies on diazo paper. To distinguish them from the original blueprint (ferro-prussiate).

WIRE STITCHING. The fastening of sheets together with wire staples.

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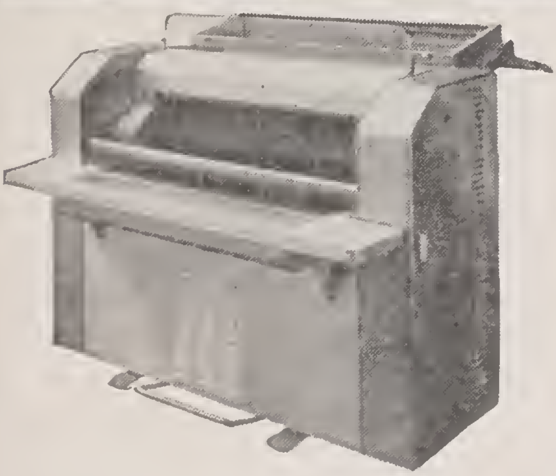

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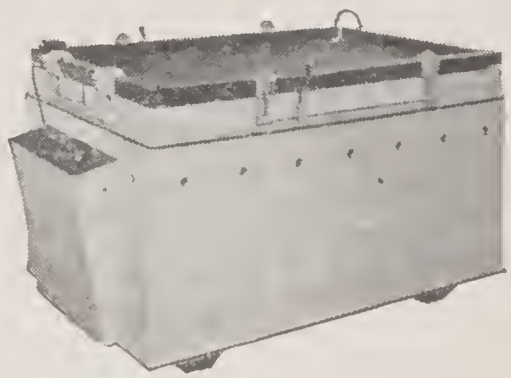

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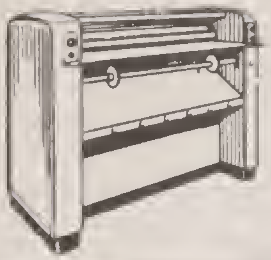

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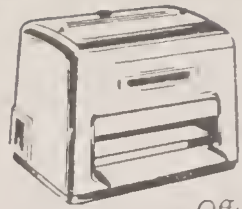

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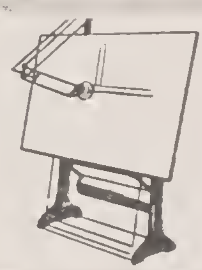

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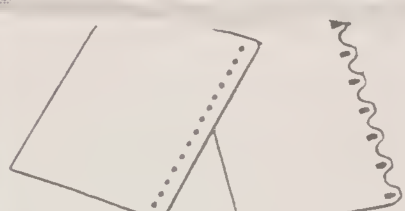

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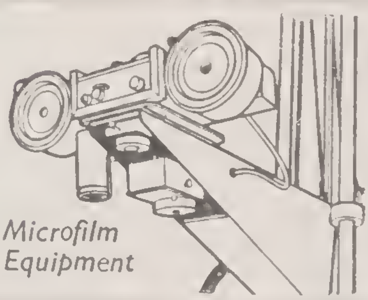

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